BRL

MEMORANDUM REPORT BRL-MR-3424

TEMPORARY TANK AMMUNITION STORAGE FACILITY

Philip M. Howe
David L. Collis

January 1985

US ARMY BALLISTIC RESEARCH LABORATORY
ABERDEEN PROVING GROUND, MARYLAND

Destroy this report when it is no longer needed.
Do not return it to the originator.

Additional copies of this report may be obtained from the National Technical Information Service, U. S. Department of Commerce, Springfield, Virginia 22161.

The findings in this report are not to be construed as an official Department of the Army position, unless so designated by other authorized documents.

The use of trade names or manufacturers' names in this report does not constitute indorsement of any commercial product.

UNCLASSIFIED
SECURITY CLASSIFICATION OF THIS PAGE *(When Data Entered)*

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER: Memorandum Report BRL-MR-3424
2. GOVT ACCESSION NO.
3. RECIPIENT'S CATALOG NUMBER

4. TITLE *(and Subtitle)*: TEMPORARY TANK AMMUNITION STORAGE FACILITY
5. TYPE OF REPORT & PERIOD COVERED
6. PERFORMING ORG. REPORT NUMBER

7. AUTHOR(s): Philip M. Howe
David L. Collis*

8. CONTRACT OR GRANT NUMBER(s)

9. PERFORMING ORGANIZATION NAME AND ADDRESS
US Army Ballistic Research Laboratory
ATTN: AMXBR-TBD
Aberdeen Proving Ground, MD 21005-5066

10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS

11. CONTROLLING OFFICE NAME AND ADDRESS
US Army Ballistic Research Laboratory
ATTN: AMXBR-OD-ST
Aberdeen Proving Ground, MD 21005-5066

12. REPORT DATE: January 1985
13. NUMBER OF PAGES: 137

14. MONITORING AGENCY NAME & ADDRESS *(if different from Controlling Office)*
15. SECURITY CLASS. *(of this report)*: UNCLASSIFIED
15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT *(of this Report)*

Approved for public release, distribution unlimited.

17. DISTRIBUTION STATEMENT *(of the abstract entered in Block 20, if different from Report)*

18. SUPPLEMENTARY NOTES

* New Mexico Institute of Mining and Technology, TERA Group

19. KEY WORDS *(Continue on reverse side if necessary and identify by block number)*

munition storage
antitank ammunition
propagation of detonation
control of explosive size

20. ABSTRACT *(Continue on reverse side if necessary and identify by block number)*

A rack for temporary storage of tank ammunition was designed and tested. Such a rack was considered to be useful for tactical units whose tanks are maintained in an uploaded configuration for improved readiness. When maintenance is performed upon these tanks, the ammunition must be offloaded in order to comply with safety requirements. A rack, which permits storage of the ammunition while maintenance is performed, and which controls explosion size and fragmentation hazards, offers significant improvements in ammunition handling and safety over current procedures.

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

UNCLASSIFIED
SECURITY CLASSIFICATION OF THIS PAGE *(When Data Entered)*

TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

I. INTRODUCTION

Currently, tank units assigned in the European theater of operations are permitted to remain in an uploaded status, with ammunition stored aboard the tanks. However, when maintenance is performed on the tanks; safety requirements dictate that the ammunition be withdrawn from the tanks and removed to a safe storage area. In some units, this means that the ammunition must be loaded back into the original packaging and transported a significant distance to an ammunition supply point. The effort described in this report has as its objective the generation of a temporary storage rack which can be placed within the maintenance area and which will meet safety criteria. Such a rack would contribute to unit operational efficiency, as well as providing an improvement in safety.

The design of the rack was predicated upon the assumption that the rack should control explosion size, thus limiting the maximum credible event to some small fraction of the total stores, and should also control fragment hazards. Work that was performed in the development of the M1 and M1E1 ammunition compartments provided much of the technical basis for this effort. Two concepts were designed and tested. One rack was fabricated from plywood. Actual implementation would require use of fire resistant treated wood to reduce fire hazards. Untreated wood provides the potential for slow burning fires which can lead to cook off of the warheads.

The second concept employed a steel rack, fabricated from angle iron and reinforcing rod as used in the building trades. Propagation of detonation was prevented by use of the fiber shipping tubes and appropriate spacing. More elaborate and more sophisticated designs could be developed, but it is unlikely that such designs could match the low costs of those described here. Fragment hazards were controlled by -

(1) Placement of fragment-producing rounds in the bottom two layers of the racks, with kinetic energy rounds (in Army jargon, armor piercing fin stabilized discarding sabot antitank ammunition) or inert plugs in the upper two layers of a four layer rack, (A single layer of sandbags is adequate to provide fragment protection.)

(2) Placement of an earthen berm around three sides of the rack to prevent escape of fragments to the side and to the rear.

II. TEST SEQUENCE

A. Preliminary Tests

A series of 11 preliminary tests was conducted to assess the propagation characteristics of the M456 HEAT round in the presence of various shielding materials. The results are summarized in Table 1 and in Figures 1 - 11.

The first test, #FBA0801A3, (the nomenclature used here is part of an internal numbering system, but is included here to permit future reference back to raw data and laboratory notebooks) was designed to assess the ability of 19-mm thick plywood to prevent propagation of detonation between HEAT rounds.

The rounds were separated 152 mm on centers. The experimental setup is shown in Figures 1a - 1c. The concrete filled adjoining compartments provided confinement to simulate the presence of additional rounds. (In actuality, the confinement provided here is more severe than would occur as a result of the presence of real rounds.) Results of deliberate detonation of the donor round are shown in Figures 1d - 1g. The donor projectile formed a jet which perforated the 2.54-cm thick mild steel witness plate. The witness plate had no other impact marks, indicating that only the donor round detonated. The acceptor projectiles were recovered, damaged, but showing no evidence of reaction. Note in Figure 1e, that acceptor #1 was crushed, with explosive pulverized and exposed. Under such circumstances, the explosive is vulnerable to fire, but is not likely to detonate, due to the absence of confinement. The results indicate that 19-mm thick plywood is adequate to prevent propagation of detonation and even prevent direct propagation of reaction between collocated M456 cartridges.

The second test, #FBA0802A3, was conducted to ascertain whether the standard fiber shipping tube would be adequate to prevent round-to-round propagation of detonation. The configuration tested is shown in Figures 2a - 2c. Results are shown in Table 2 and Figures 2d - 2h. The donor projectile formed a jet and perforated the witness plate. Neither of the other live warheads detonated. However, the witness plate shows evidence of one of the acceptor warheads impacting the witness plate sufficiently hard to form an imprint. The witness plate was positioned over 30 cm from the tip of the projectile nose booms, so a rather long time was involved between detonation of the donor and impact of the acceptor on the witness plate. Apparently, in this instance, the donor detonation caused damage to acceptor #2, but did not cause immediate violent reaction. Rather, the door caused the propellant charge in acceptor #2 to react sufficiently violently that it drove the warhead into the witness plate, at which time, and perhaps as a result of this second impact, it reacted. (Note that the diameter of the impact-induced ring on the witness plate is approximately 10.5 cm.) In any case, the reaction was sufficiently mild that one can conclude that the fiber shipping tubes are adequate to prevent propagation between M456 cartridges.

The test configuration for the third test is shown in Figures 3a - 3h. This test was similar to the previous one, but used schedule 40 PVC pipe in place of the fiber shipping tubes. The schedule 40 pipe has a 7-mm wall thickness so each pair of warheads had 14 mm of PVC shielding. Results were at least as good as those using the fiber shipping tubes. Both acceptor rounds were damaged, but there was no evidence of reaction in the explosive. The PVC, in addition to providing adequate protection against propagation of detonation, has the advantages of increased weather resistance and resistance to wear, in comparison to the fiber shipping tubes. It has the disadvantage of higher cost.

Test #4, #FBA0803A3, was conducted to determine if a 20-mm plywood barrier would be adequate to control explosion size. The test configuration is shown in Figures 4a - 4c and results are shown in Figures 4d - 4g. The results indicate that this is a borderline configuration at best. The witness plate showed evidence of a poor jet formation by one of the acceptors, indicating that it reacted very violently, approaching a detonation. The other acceptor

reacted, but without the violence of the one just described. It was concluded that this thickness of plywood was impractical to be used by itself for shielding purposes.

Test #5, #FBA0805A3, was similar to test #4, but used shields composed of two pieces of 13-mm thick plywood to give a total shield thickness between each warhead of 26 mm. The test configuration is shown in Figures 5a - 5c and the results are shown in Figures 5d - 5h. No impact marks from the acceptor warheads were observed on the witness plate, indicating that neither acceptor warheads detonated. However, the fragmentation of the warheads was such that it is clear that the warheads reacted to some extent. The level of reaction which occurred was sufficiently mild that round-to-round propagation of detonation or explosion beyond the three munitions involved here would not be expected to occur. A rack fabricated from plywood such that the shields were at least 26 mm thick would be adequate to control the size of the initial event.

For test #6, FBA0808A3, a rack was constructed from plywood boxes with 19-mm thick walls. In addition, the test was conducted with fiber shipping tubes in place, so that the total shielding each warhead had was 38 mm of plywood sandwiched between two pieces of fiber, each 25 mm thick. In the cartridge case section, the shielding was thinner, with a total of 38 mm of wood, but with fiber thickness of only 22 mm for each of two layers.

The test configuration is shown in Figures 6a - 6c and the results are shown in Figures 6d - 6h. The trend is becoming clear, the additional shielding significantly reduced damage to both acceptor warheads and cartridges. In this test, the tailbooms from both acceptors separated from the warheads and remained within the propellant case, the nose sections released in the thread sections from the warheads, and the warheads were recovered with fuze cavities and liners in place. In this test, significantly less damage was done to the propellant cartridges, as well, with a large amount of unburned propellant recovered.

Test #7, FBA0810A3, was similar to test #3, in that it used schedule 40 PVC pipe. In addition, fiber shipping tubes were used. The test configuration is shown in Figures 7a - 7c. Note the positioning of the concrete shipping tubes, which provide more confinement than would be present in an actual rack, which would have additional separation between the upper "rounds" due to the presence of the large diameter plastic pipe. Tests results are shown in Figures 7d - 7h. As can be seen from the pictures, the results are entirely consistent with earlier tests; increasing the shielding reduces the severity of the event. Both acceptor projectiles were damaged, but there is no indication of significant reaction. Similarly, both propelling charges were damaged, but the major fraction of the propellant was recovered. Examination of Figure 7d leads to the conjecture that some explosive was ejected from acceptor #1, as there appears to be a signature left by the explosive on the witness plate.

All the tests described so far relied upon shielding to prevent propagation of detonation. Clearly, some shielding is required, otherwise neighboring projectiles would be vulnerable to direct fragment impacts from the donor. In test #8, FBA0830A3, standard shipping tubes are used to provide protection from primary fragments, but spacing is used to reduce the strength of the delivered loading.

The test configuration is shown in Figures 8a - 8c, and the post test configurations are shown in Figures 8d - 8g. The results of this test are similar to test #11 and are especially interesting. The witness plate provides no evidence of jet formation for either acceptor, indicating that neither round detonated. However, there is an indentation on the witness plate from where the witness plate was impacted by acceptor #1. Here, the noseboom impacted the witness plate rather forcibly, whereas in test #11 the noseboom had evidently separated from the warhead and moved sufficiently far out of the way to permit impact by the main body of the warhead. In both tests, the donor warhead apparently did not initiate the acceptor warheads, but did initiate a sufficiently violent reaction in the propellant to allow it to forcibly launch the warhead into the witness plate. In this test, acceptor #1 reacted somewhat violently, and small pieces of the casing were recovered. It is believed that this reaction occurred as a result of the damaged acceptor impacting against the witness plate.

In test #9, FBA0831A3, wooden boxes were used to provide shielding for the warheads only. Propellant cartridges were unprotected. The test configuration is shown in Figures 9a - 9c, and the test results are shown in Figures 9d - 9h. The wooden boxes which protected the warheads had wall thickness of 16 mm, providing a total shield thickness of 32 mm of plywood. The signature on the witness plate shown in Figure 9d clearly shows the imprint resulting from the forcible impact of the two acceptor warheads. Note that the diameters of the two imprints are approximately the same as the original warhead diameters: impact on the warheads onto the witness plate occurred prior to reaction of the warheads. Nonetheless, in this test, both warheads reacted and broke into pieces. This supplies additional evidence that the warheads are reacting as a result of the impact of damaged warheads onto the witness plate.

Test #10, FBA0831B3, used shields constructed from 10-mm plywood boxes with 19-mm wooden inserts in the warhead region. Thus, each warhead was shielded from its neighbor by 58 mm of plywood and each cartridge case was shielded by 20 mm of plywood. The test configuration is shown in Figures 10a - 10c and the test results are shown in Figures 10d -10f. The shielding prevented propagation of detonation and permitted minimal damage, as can be seen in the figures. Acceptor #1 had its noseboom broken off, but the warhead, fuze, and tailboom remained with the cartridge case. The second acceptor had similar damage, remained in the cartridge case, and underwent a burning reaction which lasted for approximately 8 minutes. The sequence of events may have been - donor warhead detonates, causes damage to neighbor warheads and explosive, causes fragment initiation of a non-explosive reaction in the propellant, which then burns briefly in a torch-like fashion, causing the explosive to ignite.

The test configuration for test #11 is shown in Figures 11a - 11c and the test reults are shown in Figures 11d - 11g. In test #11, FBA0901A3, standard shipping tubes were used for shielding and warheads were placed such that there was a 51-mm air gap between shipping tubes. Neither warhead reacted violently. The tailboom of acceptor #1 separated from the warhead and remained in the propellant case, the noseboom separated from the warhead body, and the warhead body with liner in place were recovered. Similar results were obtained with acceptor #2. The small amount of damage which occurred in this test emphasizes the value of spacing in mitigating the effects of the donor.

B. Final Tests

Two full scale tests were conducted, one using a plywood rack and the other using a steel rack.

Test #12, FBA1018A3, used a plywood rack. A cinder block and earth fill revetment was placed around three sides of the rack to stop escape of hazardous fragments from the side and rear of the rack. The revetment is clearly an overkill; nowhere near that much earth is required to stop fragments from the M456 HEAT round. The minimum amount of earth barricade required for stopping hazardous fragments for various munitions will be the subject of a separate report. The test configuration is shown in Figures 12a - 12e. The rack contained a total of 20 each 105-mm munitions. The bottom row consisted of five live HEAT projectiles. The upper three rows contained 90 mm M353A1 TP-T kinetic energy rounds. The middle HEAT round was deliberately detonated. Results are shown in Figures 12h - 12r and in Table 3. The results are as expected. Only the donor round detonated. The nearest neighbor HEAT rounds suffered some mechanical damage, but there was no evidence of warhead reaction of any kind and the explosive was intact. The second nearest neighbor HEAT rounds suffered less damage, as might be expected.

The second nearest neighbor on the right side suffered more damage than the first nearest neighbor. However, even here the liner and most of the explosive were recovered in the round. Why the second nearest neighbor on the right side was more severely damaged than the nearest neighbor in unclear. However, it should be noted that the propellant cartridge of the second nearest neighbor reacted more violently than that of the first nearest neighbor. It may be that the damage resulted from the projectile being launched forcibly against a hard object by the propelling charge. The rack was destroyed. Most of the debris remained within the revetment. Flames were observed after passage of about 4 minutes. After 7 minutes passed, a propelling charge ignited and burned, followed by several other reactions. The fire persisted for a total of 35 minutes. No warheads cooked off. The ejecta pattern is shown in Figure 12r. No primary warhead fragments were recovered outside of the barricade.

The second full scale test used a steel rack instead of the wooden one. The test configuration for this test, FBA1021A3, is shown in Figures 13a - 13g and test results are shown in Table 4 and in Figures 13h - 13p. The results were quite similar to those of the previous test. Three propellant reactions were observed to occur within the first 5 seconds, followed by further reactions over the next 14 minutes. Two of the acceptor warheads started to burn at 9 minutes into the test, and burned for 7 minutes. At approximately 16 minutes, all observable fire had dissipated. All the propellant and explosive burning reactions occurred within the enclosure. No violent cook off reactions occurred. The ejecta pattern is shown in Figure 13p.

III. SUMMARY AND CONCLUSIONS

A series of tests was conducted to determine if it is feasible to store high explosive antitank ammunition in a rack in such a manner that the maximum credible event would be limited to a small number of rounds and such that the hazardous fragment distance could be limited to a few meters. The tests used

spacing and shielding to control explosion size and shielding and earthen barriers to control fragmentation. The tests showed that several combinations of shielding and spacing were adequate to prevent propagation of detonation or of violent reaction between warheads. For example, the standard fiber shipping tubes are adequate, if the rounds are configured such that there is an air space between the shipping tubes, the violence of the warhead reactions and propellant reactions are significantly reduced. Plywood, in thicknesses of ~20 mm or more are also adequate to prevent propagation. PVC pipe, schedule 40, with wall thicknesses of ~7 mm (so that total shield thickness was ~14 mm) was also found to work.

Two full scale tests involving five live HEAT warheads and fifteen armor piercing warheads in each test were conducted. One test used a plywood rack, the other used a steel rack with spacing and fiber shipping tubes used to control explosion size. In each test, the explosive warheads were placed in the bottom row, with the inert warheads placed in rows above to provide resistance to primary fragments. Revetments were used to prevent escape of side fragments and jet particles. Kickouts did occur in each test, with the maximum distance being about 58 m in one test and 180 m in the other test. The pattern of ejection was such that the furthest distances fragments were thrown were always in the direction 180 degrees with respect to the initial warhead orientation. No evidence was found indicating that any primary fragments from the donor round escaped. In each test, moderately long duration fires occurred. No violent explosive cook off reactions occurred. Because of the scattering associated with the initial event, the probability of an explosive cook off reaction has to be very remote.

No tests were conducted where the initiating event was a fire. Conceivably, a fire in the wooden rack could lead to collapse of the rack prior to cook off of the first warhead, in which case the maximum credible event could exceed one warhead. For that reason, if a wooden rack is to be used, it should be fabricated from material which has been treated with fire retardent chemicals. Such materials are available from a number of commercial sources, both here and in Europe. The steel rack, which relies on the fiber tubes for shielding, retains its integrity in a fire environment. The fiber material is combustible, but it is unlikely that shielding from a significant number of rounds would be lost prior to the first warhead cook off reaction.

It is concluded that either rack configuration offers the potential to provide storage of 105-mm tank ammunition in areas restricted to small fragment and blast hazard distances. Thus, this approach offers the potential for temporary storage of HEAT and KE rounds for uploaded tank units while maintenance is being performed on the tanks.

TABLE 1. TEMPORARY TANK AMMO STORAGE FACILITY

PRELIMINARY TESTS -- SUB SCALE

TEST NO.	SET UP	WARHEAD EFFECTIVE SHIELD	CASE EFFECTIVE SHIELD	RESULTS
FBA0801A3	19mm Wood Box	Wood 38mm	Wood 38mm	Acceptor warheads damaged, no reaction. Separated from cases.
FBA0802A3	Standard Shipping Tube	Tube 50mm	Tube 22mm	Acceptor warheads reacted. No jet formation.
FBA0802B3	7mm SCH 40 PVC	PVC 14mm	PVC 14mm	Acceptor warheads damaged, no reaction. Separated from cases.
FBA0803A3	10mm Wood Box	Wood 20mm	Wood 20mm	Acceptor warheads reacted, left one formed partial jet.
FBA0805A3	13mm Wood Box	Wood 26mm	Wood 26mm	Acceptor warheads reacted. No jet formation.
FBA0808A3	19mm Wood Box and Standard Shipping Tube	Wood 38mm Tube 50mm	Wood 38mm Tube 22mm	Acceptor warheads damaged, no reaction. Separated from cases.

TABLE 1. (CONTINUED)

TEMPORARY TANK AMMO STORAGE FACILITY

PRELIMINARY TESTS -- SUB SCALE

TEST NO.	SET UP	WARHEAD EFFECTIVE SHIELD	CASE EFFECTIVE SHIELD	RESULTS
FBA0810A3	8mm SCH 40 PVC and Standard Shipping Tube	PVC 16mm Tube 50mm	PVC 16mm Tube 22mm	Acceptor warheads damaged, no reaction. Separated from cases.
FBA0830A3	Standard Shipping Tube, Separated by 41mm Air Gap	Tube 50mm	Tube 22mm	A2 acceptor warhead damaged, and separated from case. A1 acceptor warhead reacted.
FBA0831A3	16mm Wood Box	Wood 32mm	None	Acceptor warheads reacted. No jet formation.
FBA0831B3	10mm Wood Box and 19mm Insert Wood Box	Wood 58mm	Wood 20mm	A1 acceptor warhead damaged, no reaction. A2 acceptor warhead burned, no jet formation
FBA0901A3	Standard Shipping Tube Separated by 51mm Air Gap	Tube 50mm	Tube 22mm	A2 acceptor and case slight damaged. A1 acceptor damaged and separated from case. No reaction.

TABLE 1. (CONTINUED)

TEMPORARY TANK AMMO STORAGE FACILITY

FINAL TESTS -- FULL SCALE

TEST NO.	SET UP	WARHEAD EFFECTIVE SHIELD	CASE EFFECTIVE SHIELD	RESULTS
FBA1018A3	19mm Wood Box	Wood 38mm	Wood 38mm	L-2 acceptor warhead and case slightly damaged. L-1, R-1 and R-2 acceptor warheads damaged and separated from cases. No reaction.
FBA1021A3	Standard Shipping Tube, Vertical Air Gap 95mm, Horizontal Air Gap 70mm	Tube 50mm	Tube 22mm	R-1 and R-2 acceptor warheads damaged, separated from cases. No reaction. L-1 and L-2 acceptor warheads burned, separated from cases.

TEST: FBA0801A3
DATE: 1 AUGUST 1983
TIME: 15:47 MDT

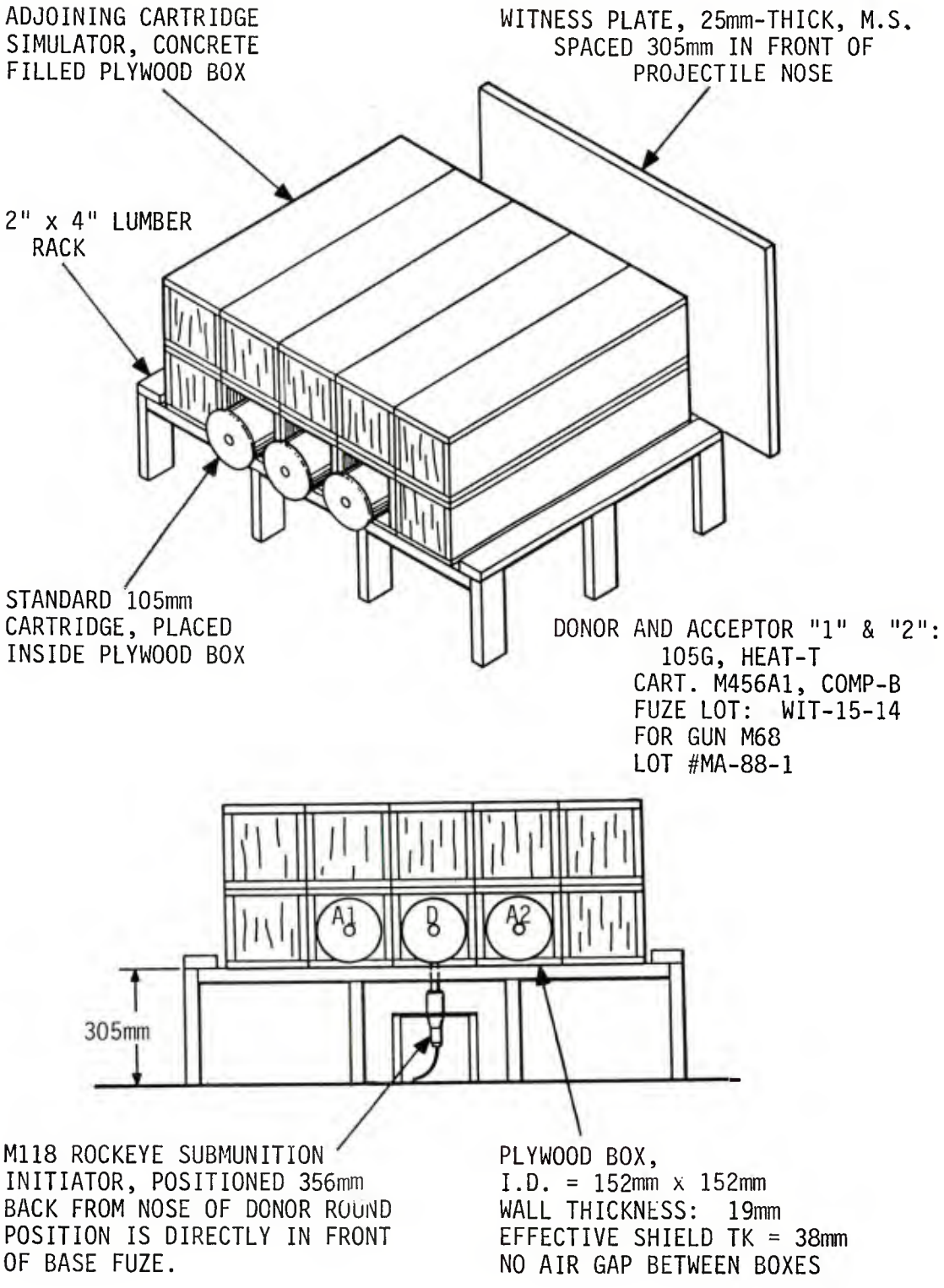
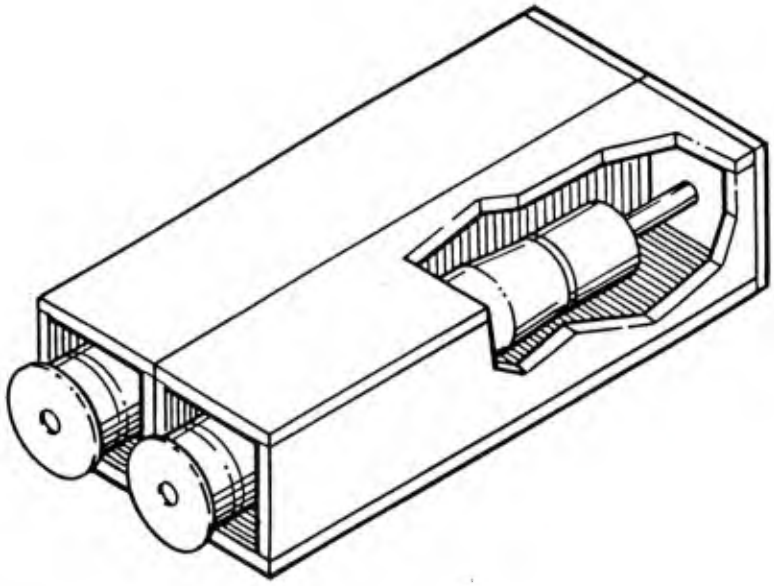
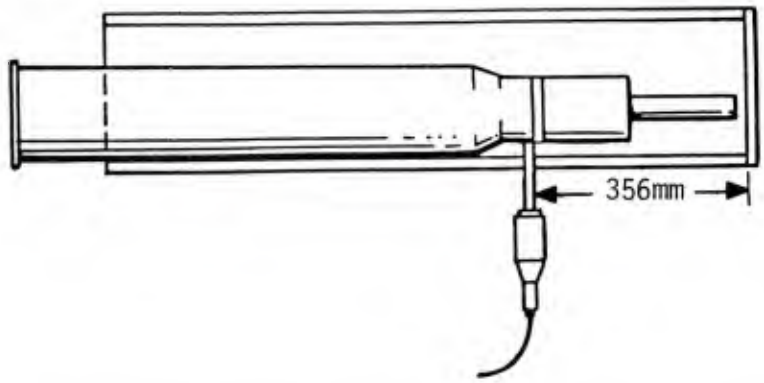


Figure 1a. Test FBA0801A3

TEST: FBA0801A3
DATE: 1 AUGUST 1983
TIME: 15:47 MDT



TYPICAL PLACEMENT OF FIXED CARTRIDGE IN WOODEN BOX



PLACEMENT OF M118 ROCKEYE FOR DETONATION OF HEAT PROJECTILE. ROCKEYE PLACEMENT WAS JUST FORWARD OF BASE FUZE.

Figure 1b. Test FBA0801A3

TEST: FBA0801A3
DATE: 1 AUGUST 1983
TIME: 15:47 MDT

SIDE VIEW OF SETUP - BEFORE TEST

FRONT VIEW OF SETUP - BEFORE TEST

Figure 1c. Test FBA0801A3

TEST: FBA0801A3
DATE: 1 AUGUST 1983
TIME: 15:47 MDT

TABLE 2. TEMPORARY TANK AMMUNITION STORAGE FACILITY

RESULTS:

Donor projectile formed jet and perforated one inch mild steel witness plate. No impact marks from acceptors on witness plate.

Acceptor projectiles received the following damage:

A1 - Tailboom separated and stayed in case, standoff nose separated, warhead with fuze and damaged liner recovered at 17.9m on a 90° line left of Rockeye initiation of donor warhead.

A2 - Standoff nose separated, with warhead, fuze and tailboom remaining in cartridge case and recovered at 5.7m on a 45° line right of initiation point.

Donor cartridge case fragments recovered at 85.6m on a 0° line off initiation point.

Several concrete fragments of the cartridge simulators were recovered in a 200° arc around initiation point, with a maximum distance of 37.1m.

TEST: FBA0801A3
DATE: 1 AUGUST 1983
TIME: 15:47 MDT

DONOR CASE FRAGMENT - AFTER TEST

WITNESS PLATE - AFTER TEST
ONLY APPARENT JET FORMATION WAS FROM DONOR PROJECTILE

Figure 1d. Test FBA0801A3

TEST: FBA0801A3
DATE: 1 AUGUST 1983
TIME: 15:47 MDT

ACCEPTOR #1 - WARHEAD WITH FUZE AND
DAMAGED LINER - AFTER TEST

ACCEPTOR #1 - STANDOFF NOSE - AFTER TEST

Figure 1e. Test FBA0801A3

TEST: FBA0801A3
DATE: 1 AUGUST 1983
TIME: 15:47 MDT

ACCEPTOR #1 - DAMAGED CARTRIDGE CASE - AFTER TEST

Figure 1f. Test FBA0801A3

TEST: FBA0801A3
DATE: 1 AUGUST 1983
TIME: 15:47 MDT

ACCEPTOR #2 - DAMAGED CARTRIDGE CASE AND WARHEAD
AFTER TEST

STANDOFF NOSE REMOVED. FUZE STILL INTACT - AFTER TEST

Figure 1g. Test FBA0801A3

TEST: FBA0802A3
DATE: 2 AUGUST 1983
TIME: 11:10 MDT

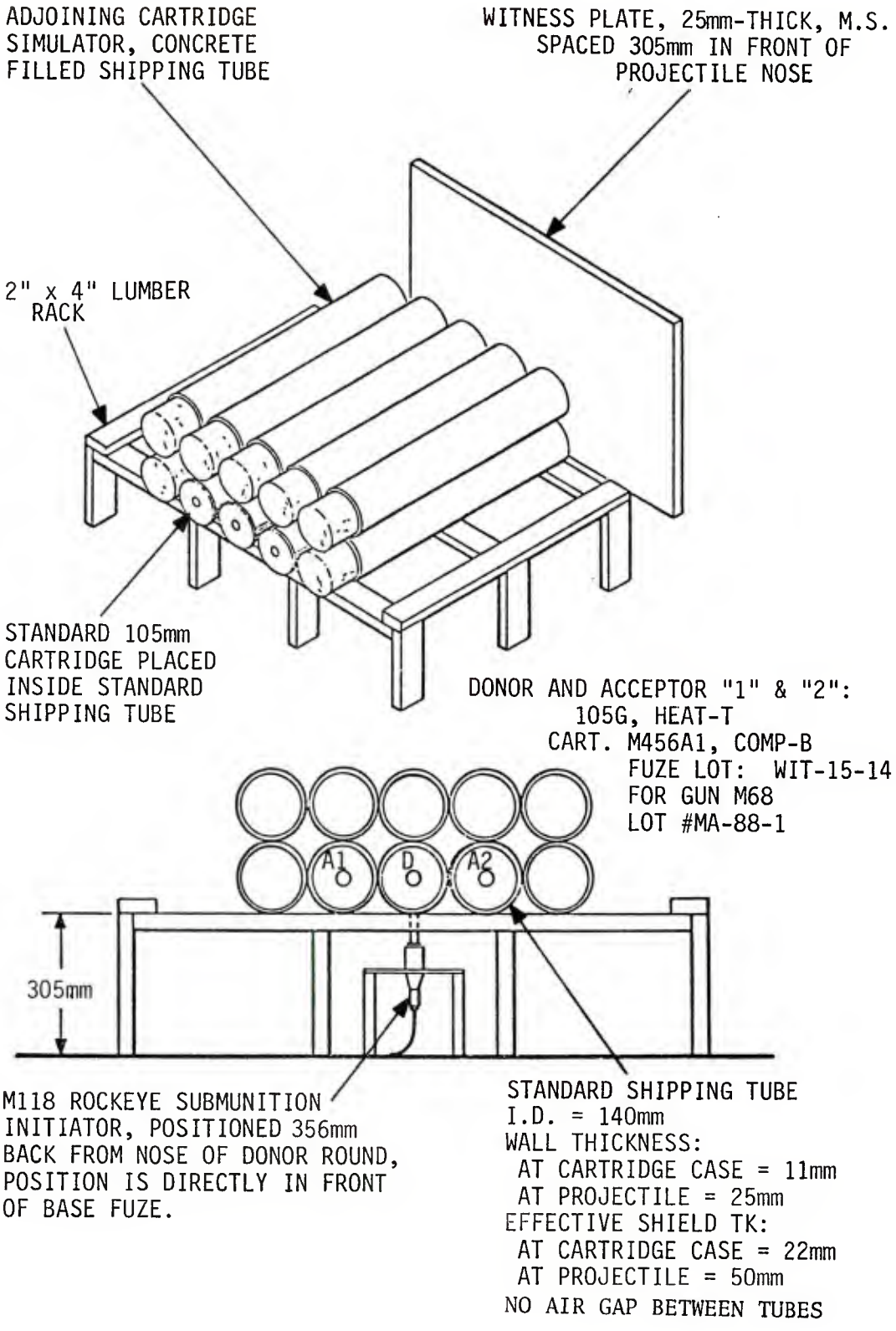
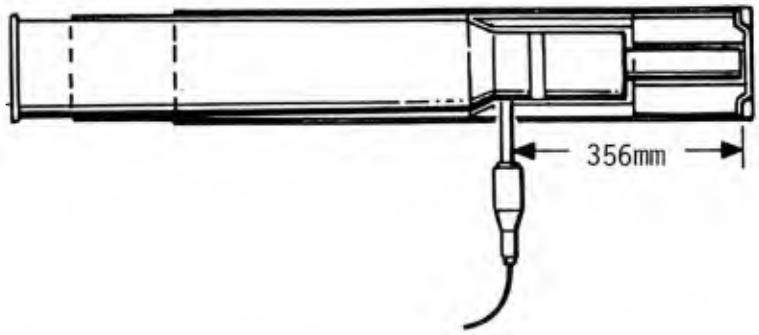


Figure 2a. Test FBA0802A3

TEST: FBA0802A3
DATE: 2 AUGUST 1983
TIME: 11:10 MDT

TYPICAL PLACEMENT OF FIXED CARTRIDGE IN STANDARD SHIPPING TUBE



PLACEMENT OF M118 ROCKEYE FOR DETONATION OF HEAT PROJECTILE. ROCKEYE PLACEMENT WAS JUST FORWARD OF BASE FUZE.

Figure 2b. Test FBA0802A3

TEST: FBA0802A3
DATE: 2 AUGUST 1983
TIME: 11:10 MDT

SIDE VIEW OF SETUP - BEFORE TEST

FRONT VIEW OF SETUP - BEFORE TEST

Figure 2c. Test FBA0802A3

TEST: FBA0802A3
DATE: 2 AUGUST 1983
TIME: 11:10 MDT

DONOR CASE FRAGMENT - AFTER TEST

WITNESS PLATE - AFTER TEST

ONLY APPARENT JET FORMATION WAS FROM DONOR PROJECTILE. REACTION FROM A2 ACCEPTOR PROJECTILE LEFT AN INDENTION IN WITNESS PLATE. THERE WAS NO EVIDENCE OF JET FORMATION.

Figure 2d. Test FBA0802A3

TEST: FBA0802A3
DATE: 2 AUGUST 1983
TIME: 11:10 MDT

ACCEPTOR #1 - WARHEAD FUZE CAVITY AND TAILBOOM
AFTER TEST

ACCEPTOR #1 - DAMAGED LINER FROM WARHEAD
AFTER TEST

Figure 2e. Test FBA0802A3

TEST: FBA0802A3
DATE: 2 AUGUST 1983
TIME: 11:10 MDT

ACCEPTOR #1 - DAMAGED CARTRIDGE CASE AND SHIPPING TUBE AFTER TEST

Figure 2f. Test FBA0802A3

TEST: FBA0802A3
DATE: 2 AUGUST 1983
TIME: 11:10 MDT

ACCEPTOR #2 - STANDOFF NOSE - AFTER TEST

ACCEPTOR #2 - WARHEAD FUZE CAVITY AND TAILBOOM
AFTER TEST

Figure 2g. Test FBA0802A3

TEST: FBA0802A3
DATE: 2 AUGUST 1983
TIME: 11:10 MDT

ACCEPTOR #2 - CARTRIDGE CASE FRAGMENT - AFTER TEST

Figure 2h. Test FBA0802A3

TEST: FBA0802B3
DATE: 2 AUGUST 1983
TIME: 15:45 MDT

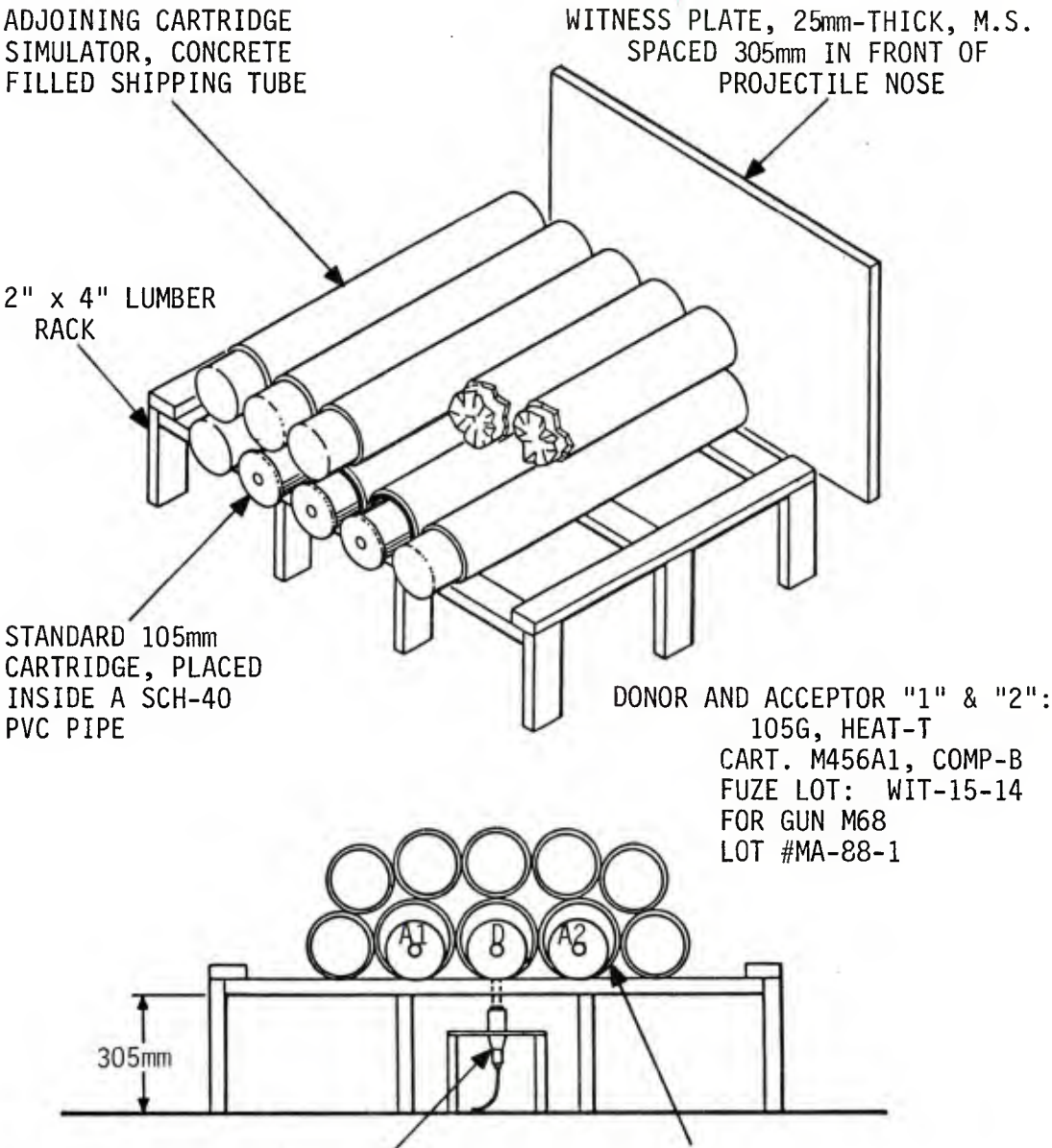
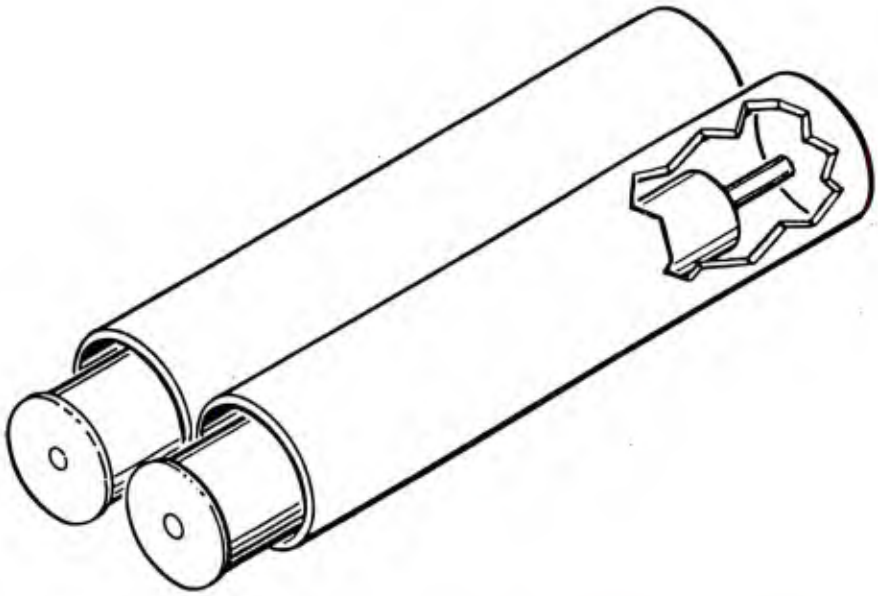
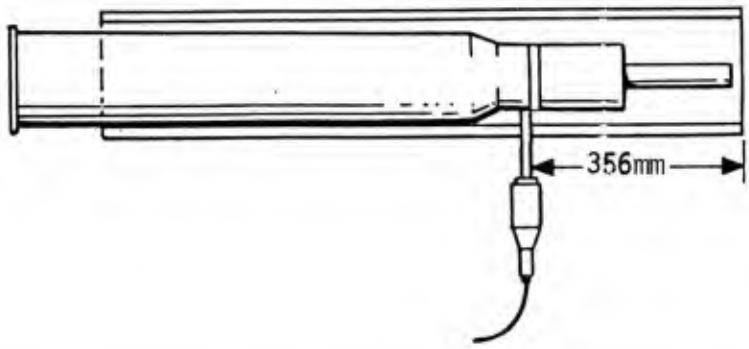


Figure 3a. Test FBA0802B3

TEST: FBA0802B3
DATE: 2 AUGUST 1983
TIME: 15:45 MDT



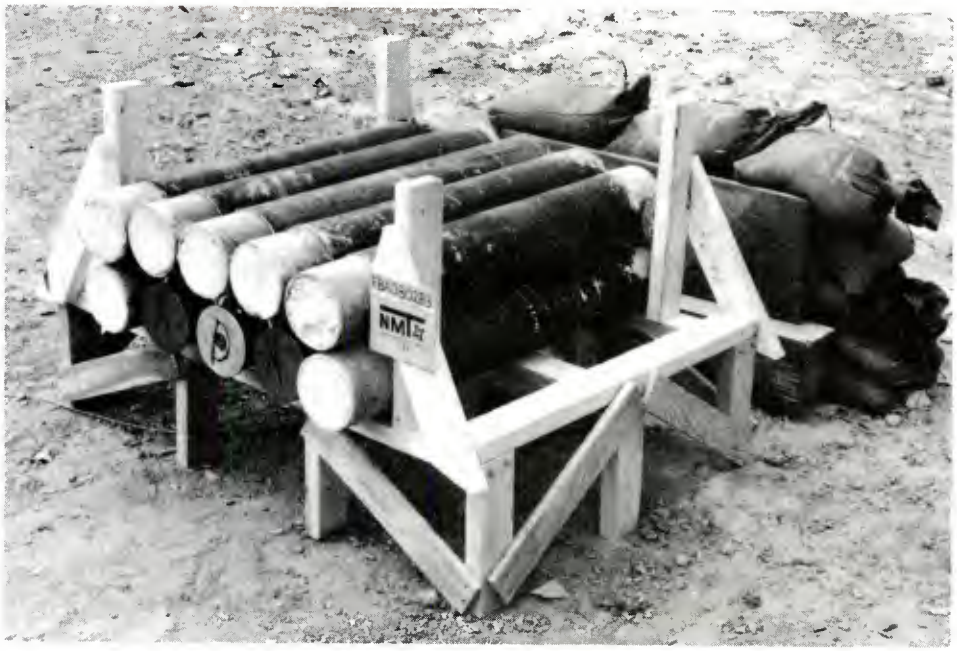
TYPICAL PLACEMENT OF FIXED CARTRIDGE IN SCH 40 PVC PIPE



PLACEMENT OF M118 ROCKEYE FOR DETONATION OF HEAT PROJECTILE. ROCKEYE PLACEMENT WAS JUST FORWARD OF BASE FUZE.

Figure 3b. Test FBA0802B3

TEST: FBA0802B3
DATE: 2 AUGUST 1983
TIME: 15:45 MDT



SIDE VIEW OF SETUP - BEFORE TEST

FRONT VIEW OF SETUP - BEFORE TEST

Figure 3c. Test FBA0802B3

TEST: FBA0802B3
DATE: 2 AUGUST 1983
TIME: 15:45 MDT

DONOR CASE FRAGMENT - AFTER TEST

WITNESS PLATE - AFTER TEST
ONLY APPARENT JET FORMATION WAS FROM DONOR PROJECTILE

Figure 3d. Test FBA0802B3

TEST: FBA0802B3
DATE: 2 AUGUST 1983
TIME: 15:45 MDT

ACCEPTOR #1 - DAMAGED WARHEAD AND FUZE CAVITY
AFTER TEST

ACCEPTOR #1 - STANDOFF NOSE - AFTER TEST

Figure 3e. Test FBA0802B3

TEST: FBA0802B3
DATE: 2 AUGUST 1983
TIME: 15:45 MDT

ACCEPTOR #1 - DAMAGED CARTRIDGE CASE - AFTER TEST

Figure 3f. Test FBA0802B3

TEST: FBA0802B3
DATE: 2 AUGUST 1983
TIME: 15:45 MDT

ACCEPTOR #2 - DAMAGED WARHEAD AND FUZE CAVITY
AFTER TEST

ACCEPTOR #2 - STANDOFF NOSE - AFTER TEST

Figure 3g. Test FBA0802B3

TEST: FBA0802B3
DATE: 2 AUGUST 1983
TIME: 15:45 MDT

ACCEPTOR #2 - DAMAGED CARTRIDGE CASE - AFTER TEST

Figure 3h. Test FBA0802B3

TEST: FBA0803A3
DATE: 3 AUGUST 1983
TIME: 11:05 MDT

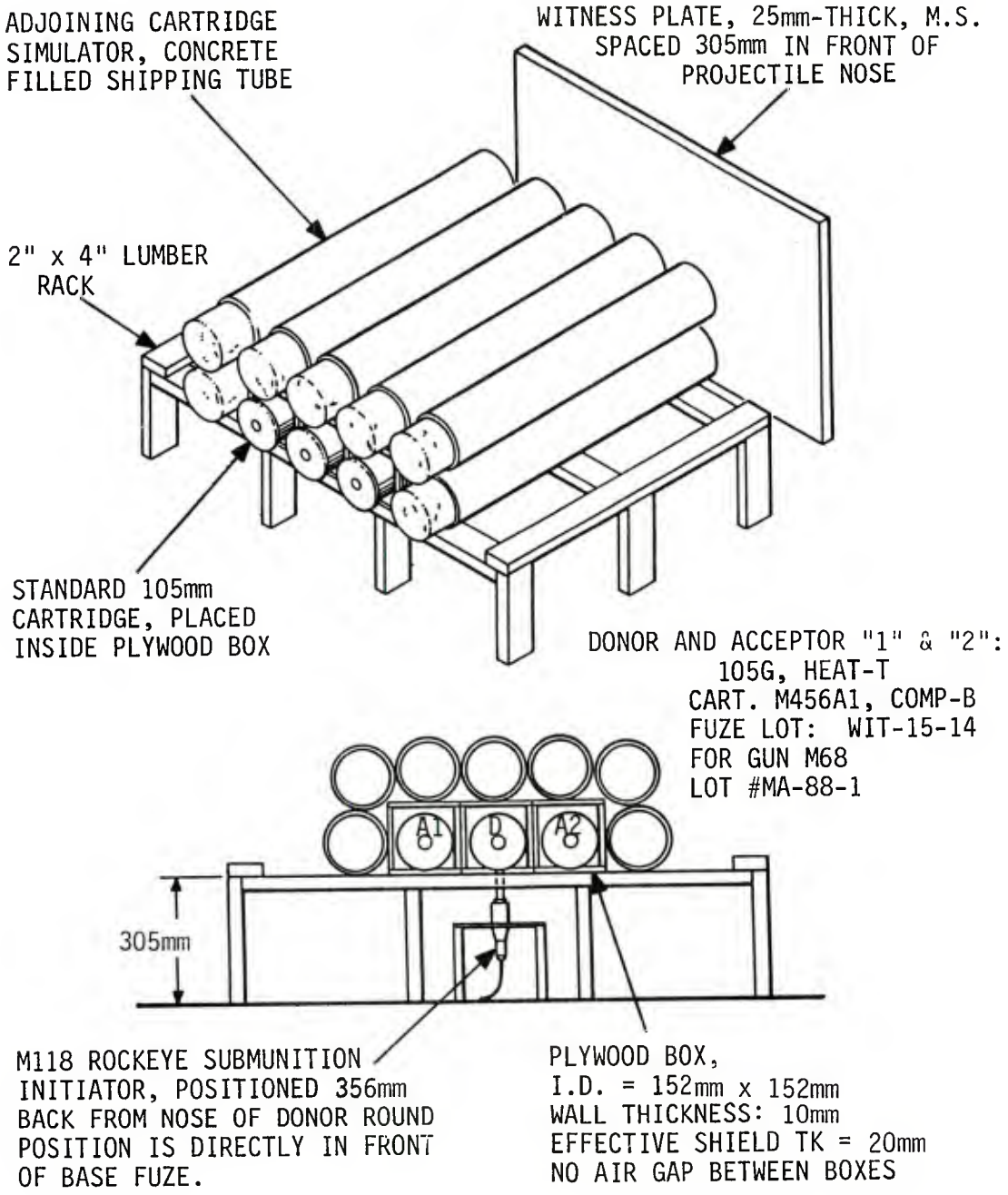
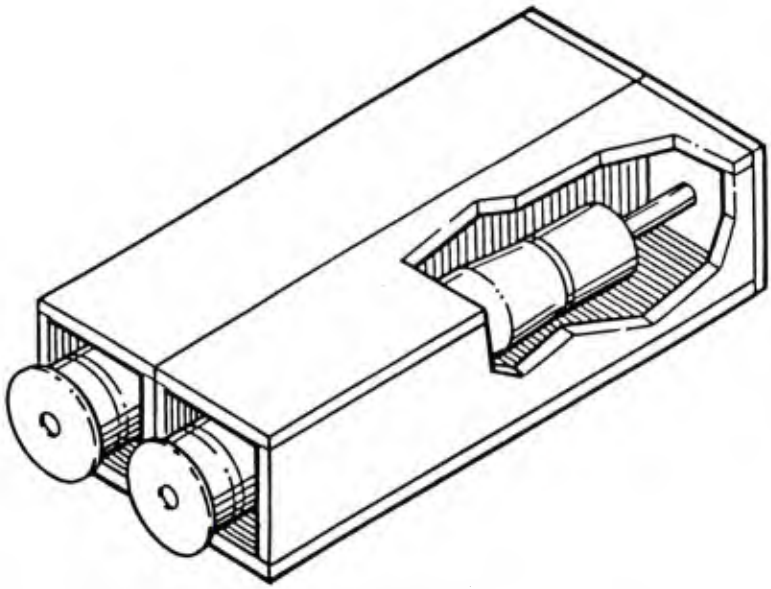
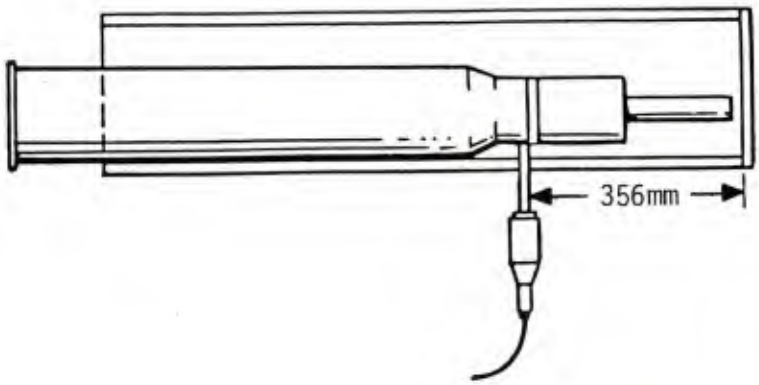


Figure 4a. Test FBA0803A3

TEST: FBA0803A3
DATE: 3 AUGUST 1983
TIME: 11:05 MDT



TYPICAL PLACEMENT OF FIXED CARTRIDGE IN WOODEN BOX



PLACEMENT OF M118 ROCKEYE FOR DETONATION OF HEAT PROJECTILE. ROCKEYE PLACEMENT WAS JUST FORWARD OF BASE FUZE.

Figure 4b. Test FBA0803A3

TEST: FBA0803A3
DATE: 3 AUGUST 1983
TIME: 11:05 MDT

SIDE VIEW OF SETUP - BEFORE TEST

FRONT VIEW OF SETUP - BEFORE TEST

Figure 4c. Test FBA0803A3

TEST: FBA0803A3
DATE: 3 AUGUST 1983
TIME: 11:05 MDT

DONOR CASE FRAGMENT - AFTER TEST

WITNESS PLATE - AFTER TEST

ONLY APPARENT COMPLETE JET FORMATION WAS FROM DONOR PROJECTILE, PARTIAL JET FORMATION FROM ACCEPTOR #1.

Figure 4d. Test FBA0803A3

TEST: FBA0803A3
DATE: 3 AUGUST 1983
TIME: 11:05 MDT

ACCEPTOR #1 - DAMAGED CARTRIDGE CASE - AFTER TEST

ACCEPTOR #1 - FUZE CAVITY FRAGMENT - AFTER TEST

Figure 4e. Test FBA0803A3

TEST: FBA0803A3
DATE: 3 AUGUST 1983
TIME: 11:05 MDT

ACCEPTOR #2 - DAMAGED FUZE CAVITY AND TAILBOOM

ACCEPTOR #2 - DAMAGED LINER - AFTER TEST

Figure 4f. Test FBA0803A3

TEST: FBA0803A3
DATE: 3 AUGUST 1983
TIME: 11:05 MDT

ACCEPTOR #2 - DAMAGED CARTRIDGE CASE - AFTER TEST

ACCEPTOR #2 - DAMAGED STANDOFF NOSE - AFTER TEST

Figure 4g. Test FBA0803A3

TEST: FBA0805A3
DATE: 5 AUGUST 1983
TIME: 14:55 MDT

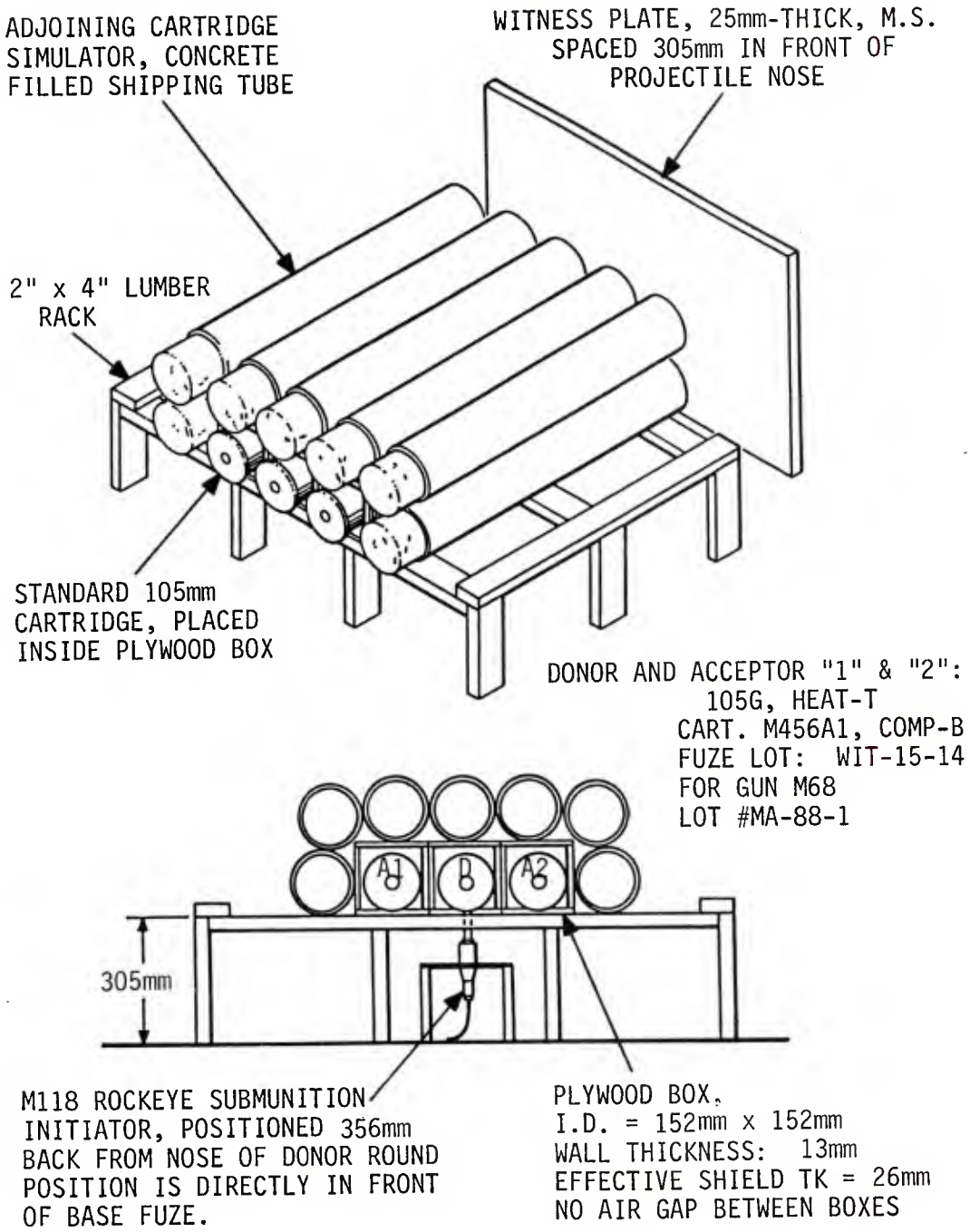
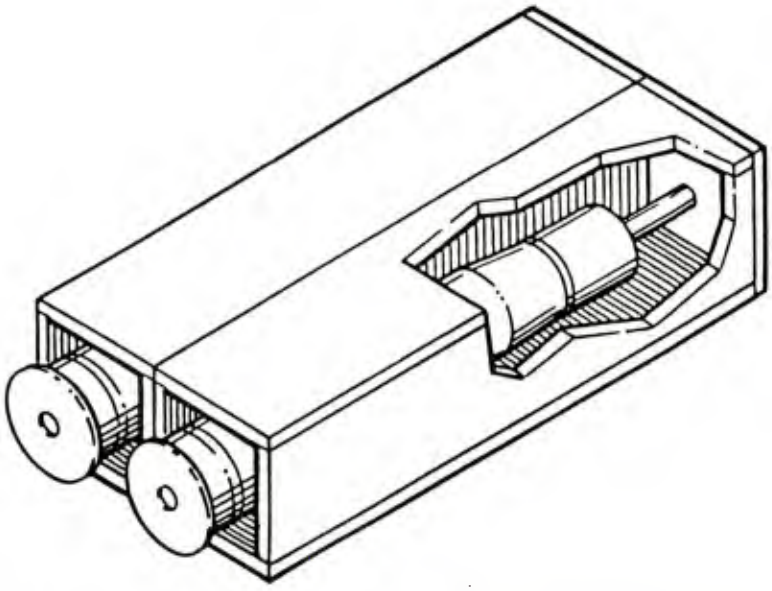
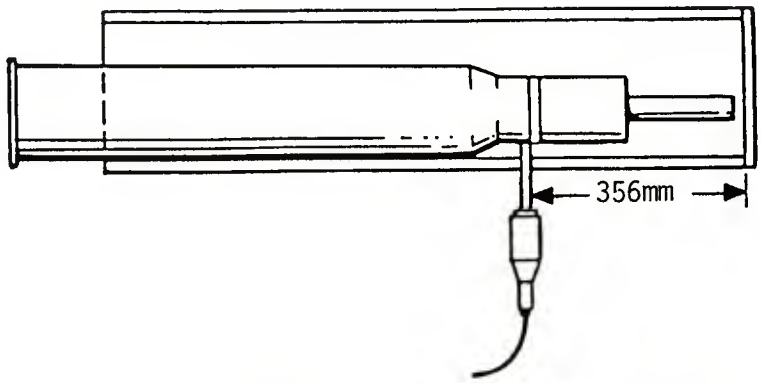


Figure 5a. Test FBA0805A3

TEST: FBA0805A3
DATE: 5 AUGUST 1983
TIME: 14:55 MDT



TYPICAL PLACEMENT OF FIXED CARTRIDGE IN WOODEN BOX

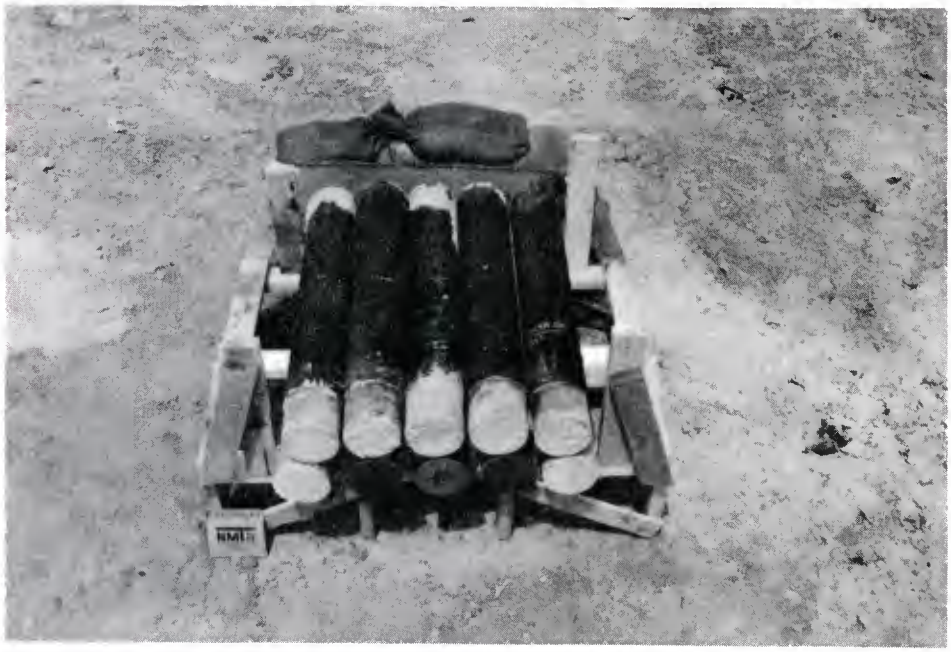


PLACEMENT OF M118 ROCKEYE FOR DETONATION OF HEAT PROJECTILE. ROCKEYE PLACEMENT WAS JUST FORWARD OF BASE FUZE.

Figure 5b. Test FBA0805A3

TEST: FBA0805A3
DATE: 5 AUGUST 1983
TIME: 14:55 MDT

SIDE VIEW OF SETUP - BEFORE TEST



FRONT VIEW OF SETUP - BEFORE TEST

Figure 5c. Test FBA0805A3

TEST: FBA0805A3
DATE: 5 AUGUST 1983
TIME: 14:55 MDT

DONOR CASE FRAGMENT - AFTER TEST

WITNESS PLATE - AFTER TEST
ONLY APPARENT JET FORMATION WAS FROM DONOR PROJECTILE

Figure 5d. Test FBA0805A3

TEST: FBA0805A3
DATE: 5 AUGUST 1983
TIME: 14:55 MDT

ACCEPTOR #1 - FUZE CAVITY AND TAILBOOM FRAGMENT
AFTER TEST

ACCEPTOR #1 - WARHEAD FRAGMENT - AFTER TEST

Figure 5e. Test FBA0805A3

TEST: FBA0805A3
DATE: 5 AUGUST 1983
TIME: 14:55 MDT

ACCEPTOR #1 - CARTRIDGE CASE FRAGMENT - AFTER TEST

Figure 5f. Test FBA0805A3

TEST: FBA0805A3
DATE: 5 AUGUST 1983
TIME: 14:55 MDT

ACCEPTOR #2 - WARHEAD FUZE CAVITY FRAGMENTS
AFTER TEST

ACCEPTOR #2 - DAMAGED LINER FROM WARHEAD

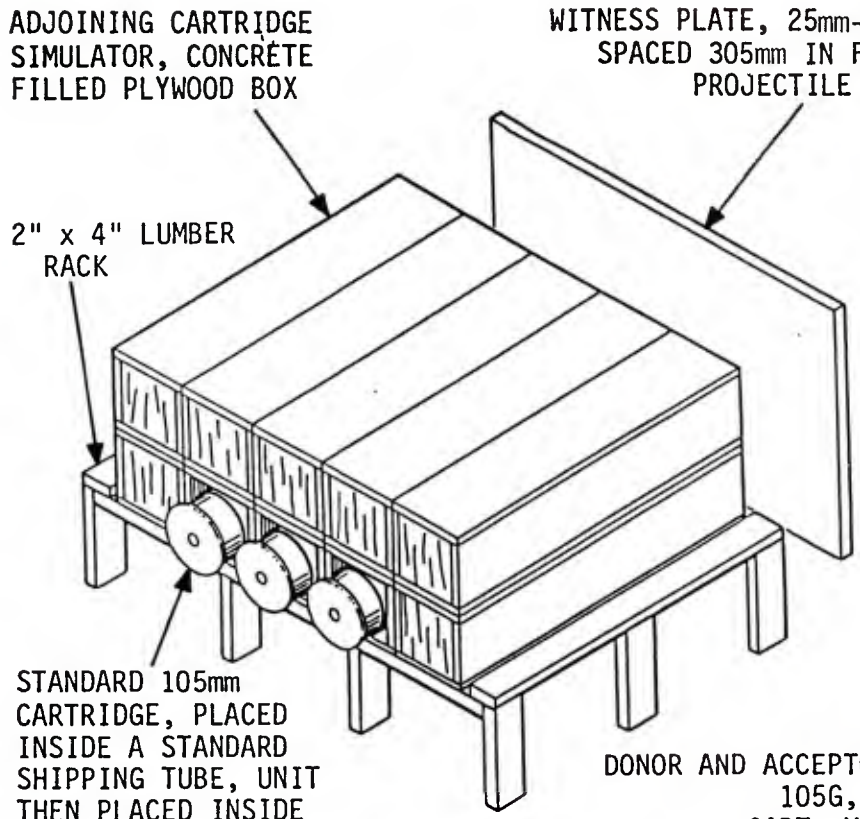
Figure 5g. Test FBA0805A3

TEST: FBA0805A3
DATE: 5 AUGUST 1983
TIME: 14:55 MDT

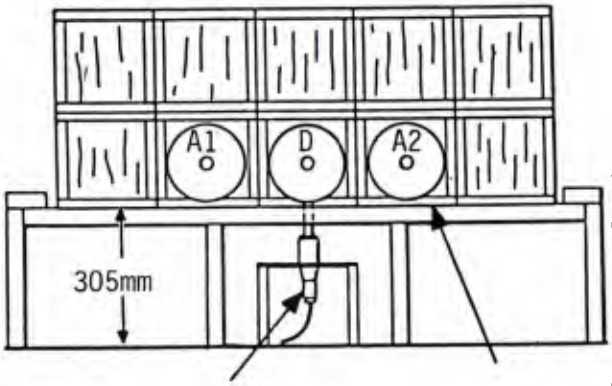
ACCEPTOR #2 - DAMAGED CARTRIDGE CASE
AFTER TEST

Figure 5h. Test FBA0805A3

TEST: FBA0808A3
DATE: 8 AUGUST 1983
TIME: 10:10 MDT



DONOR AND ACCEPTOR "1" & "2":
105G, HEAT-T
CART. M456A1, COMP-B
FUZE LOT: WIT-15-14
FOR GUN M68
LOT #MA-88-1

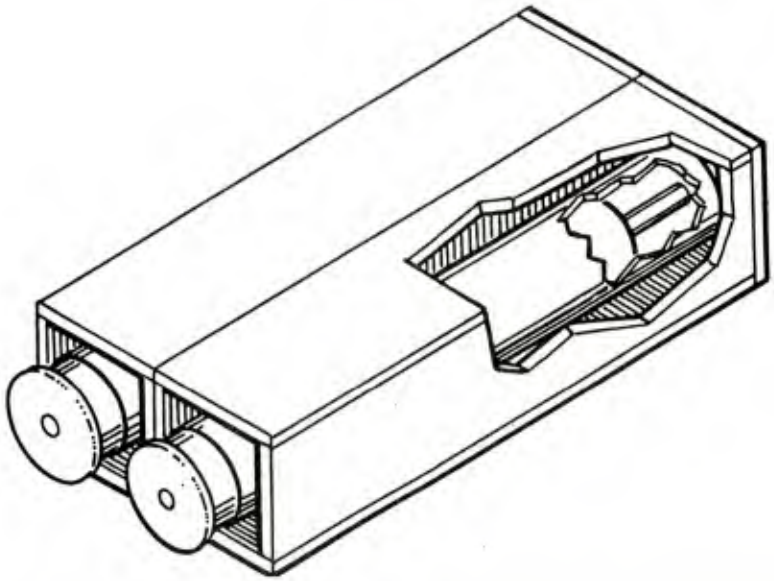


M118 ROCKEYE SUBMUNITION INITIATOR, POSITIONED 356mm BACK FROM NOSE OF DONOR ROUND POSITION IS DIRECTLY IN FRONT OF BASE FUZE.

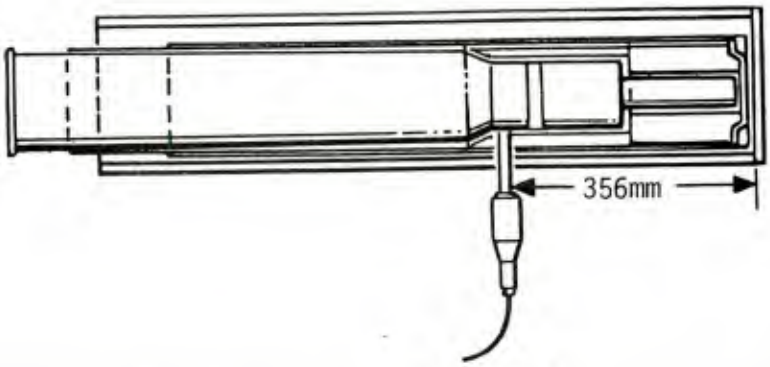
STANDARD SHIPPING TUBE,
I.D. = 140mm
WALL THICKNESS:
AT CARTRIDGE CASE = 11mm
AT PROJECTILE = 25mm
PLYWOOD BOX,
I.D. = 178mm x 178mm
WALL THICKNESS: 19mm
EFFECTIVE SHIELD TK: WOOD = 38mm
SHIPPING TUBE,
AT CARTRIDGE CASE = 22mm
AT PROJECTILE = 50mm
NO AIR GAP BETWEEN BOXES
AIR GAP BETWEEN SHIPPING TUBE AND WOOD BOX = 10mm

Figure 6a. Test FBA0808A3

TEST: FBA0808A3
DATE: 8 AUGUST 1983
TIME: 10:10 MDT



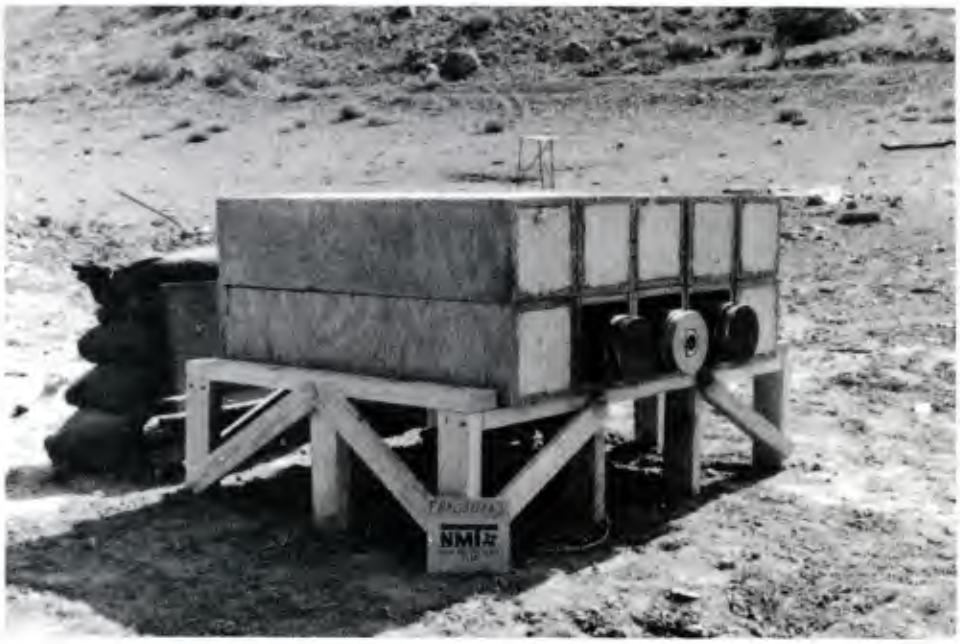
TYPICAL PLACEMENT OF FIXED CARTRIDGE IN STANDARD SHIPPING TUBE. UNIT THEN PLACED INSIDE PLYWOOD BOX.



PLACEMENT OF M118 ROCKEYE FOR DETONATION OF HEAT PROJECTILE. ROCKEYE PLACEMENT WAS JUST FORWARD OF BASE FUZE.

Figure 6b. Test FBA0808A3

TEST: FBA0808A3
DATE: 8 AUGUST 1983
TIME: 10:10 MDT



SIDE VIEW OF SETUP - BEFORE TEST

FRONT VIEW OF SETUP - BEFORE TEST

Figure 6c. Test FBA0808A3

TEST: FBA0808A3
DATE: 8 AUGUST 1983
TIME: 10:10 MDT

DONOR CASE FRAGMENT - AFTER TEST

WITNESS PLATE - AFTER TEST
ONLY APPARENT JET FORMATION WAS FROM DONOR PROJECTILE

Figure 6d. Test FBA0808A3

TEST: FBA0808A3
DATE: 8 AUGUST 1983
TIME: 10:10 MDT

ACCEPTOR #1 - STANDOFF NOSE - AFTER TEST

ACCEPTOR #1 - DAMAGED WARHEAD - AFTER TEST

Figure 6e. Test FBA0808A3

TEST: FBA0808A3
DATE: 8 AUGUST 1983
TIME: 10:10 MDT

ACCEPTOR #1 - DAMAGED CARTRIDGE CASE AND SHIPPING TUBE AFTER TEST

Figure 6f. Test FBA0808A3

TEST: FBA0808A3
DATE: 8 AUGUST 1983
TIME: 10:10 MDT

ACCEPTOR #2 - STANDOFF NOSE - AFTER TEST

ACCEPTOR #2 - DAMAGED WARHEAD - AFTER TEST

Figure 6g. Test FBA0808A3

TEST: FBA0808A3
DATE: 8 AUGUST 1983
TIME: 10:10 MDT

ACCEPTOR #2 - DAMAGED CARTRIDGE CASE AND SHIPPING TUBE AFTER TEST

Figure 6h. Test FBA0808A3

TEST: FBA0810A3
DATE: 10 AUGUST 1983
TIME: 15:18 MDT

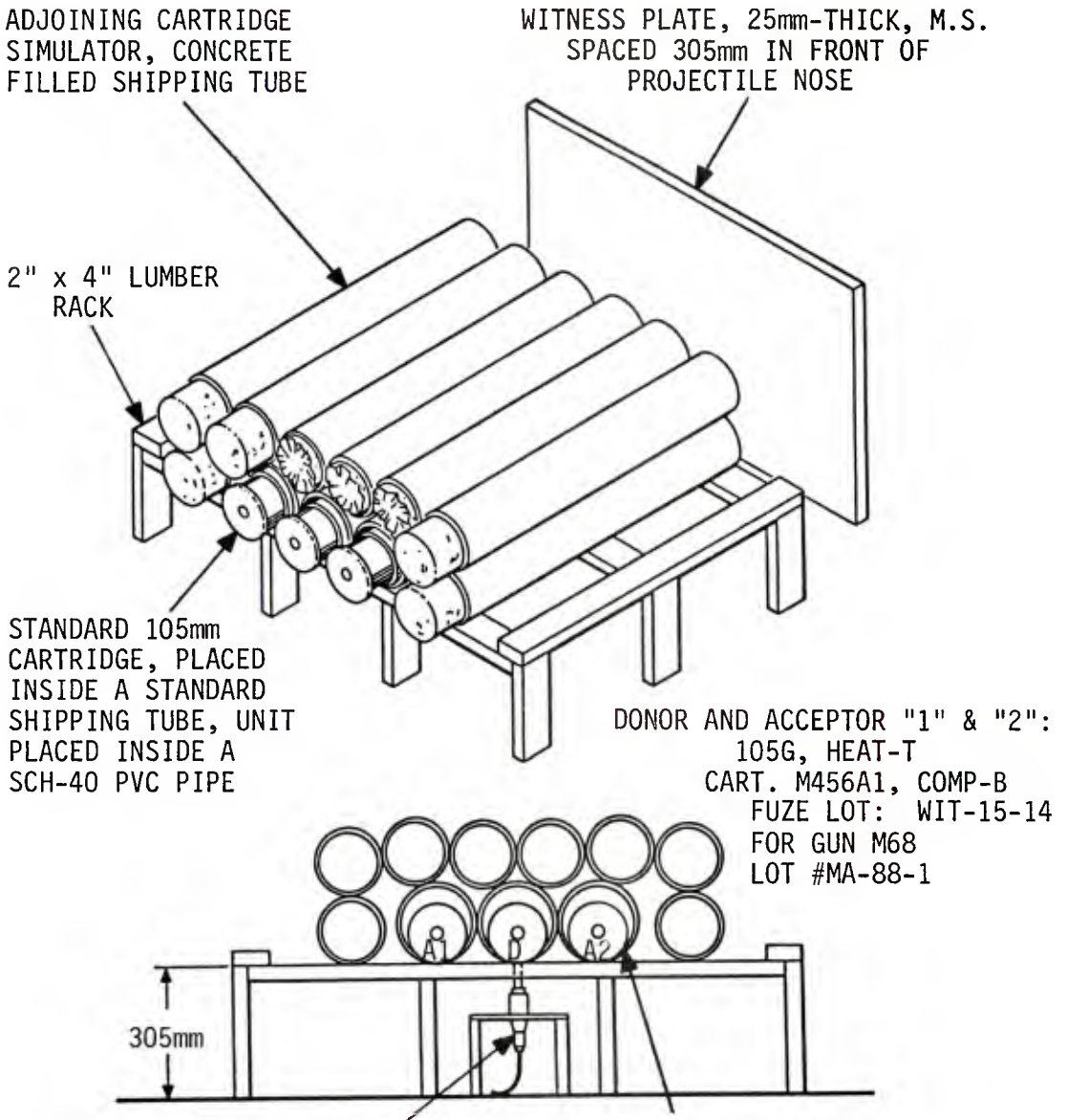
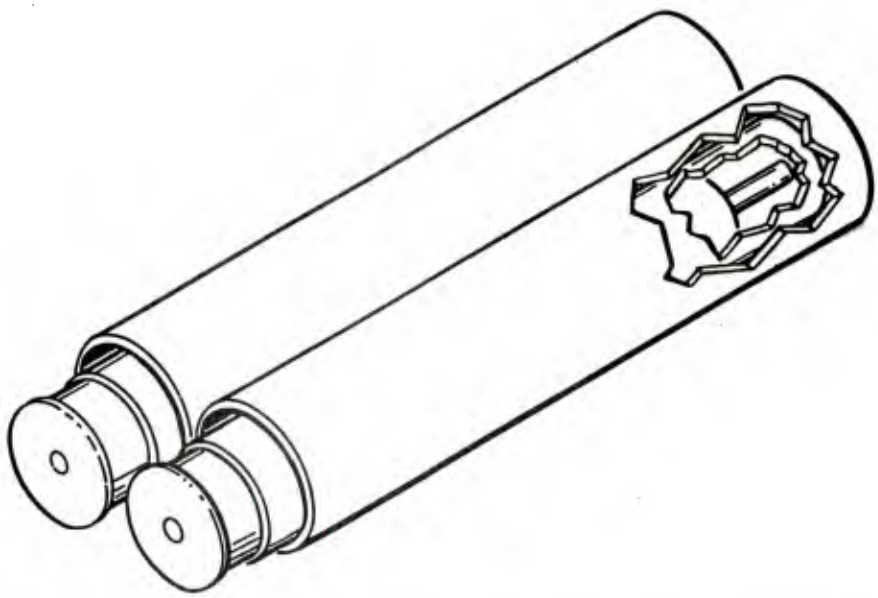
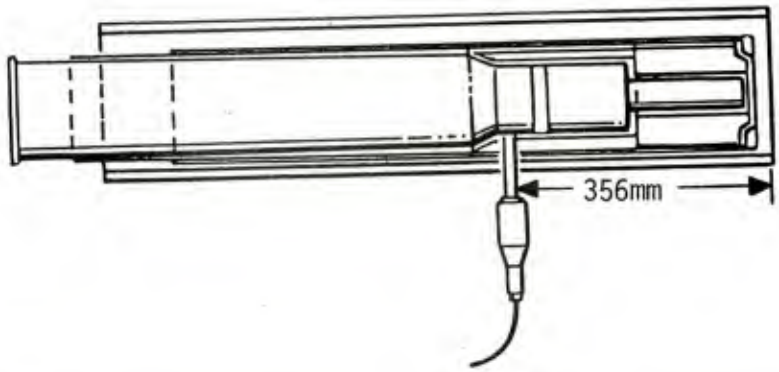


Figure 7a. Test FBA0810A3

TEST: FBA0810A3
DATE: 10 AUGUST 1983
TIME: 15:18 MDT



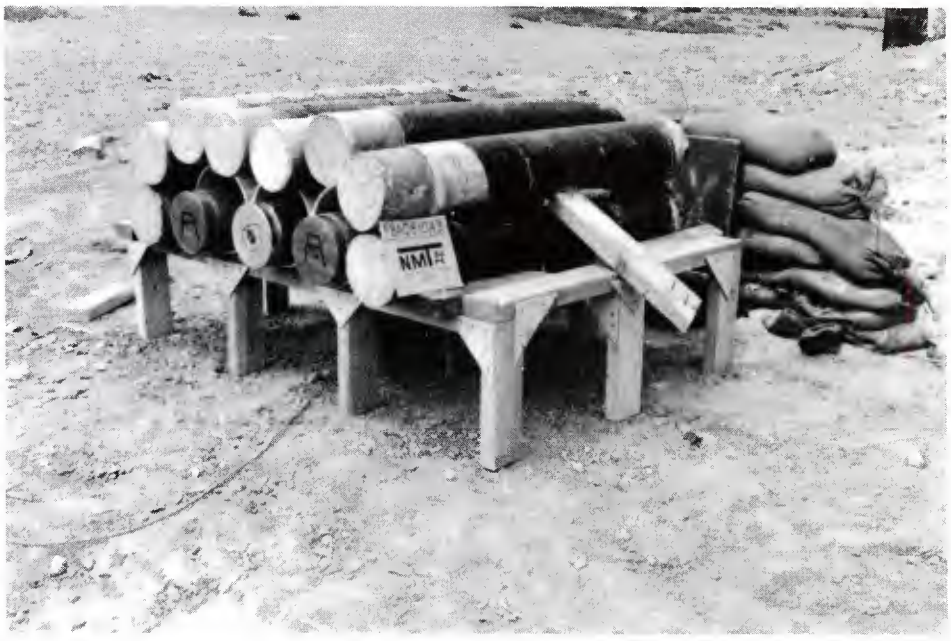
TYPICAL PLACEMENT OF FIXED CARTRIDGE IN STANDARD SHIPPING TUBE. UNIT THEN PLACED INSIDE SCH40 PVC PIPE.



PLACEMENT OF M118 ROCKEYE FOR DETONATION OF HEAT PROJECTILE. ROCKEYE PLACEMENT WAS JUST FORWARD OF BASE FUZE.

Figure 7b. Test FBA0810A3

TEST: FBA0810A3
DATE: 10 AUGUST 1983
TIME: 15:18 MDT



SIDE VIEW OF SETUP - BEFORE TEST

FRONT VIEW OF SETUP - BEFORE TEST

Figure 7c. Test FBA0810A3

TEST: FBA0810A3
DATE: 10 AUGUST 1983
TIME: 15:18 MDT

DONOR CASE FRAGMENT - AFTER TEST

WITNESS PLATE - AFTER TEST
ONLY APPARENT JET FORMATION WAS FROM DONOR

Figure 7d. Test FBA0810A3

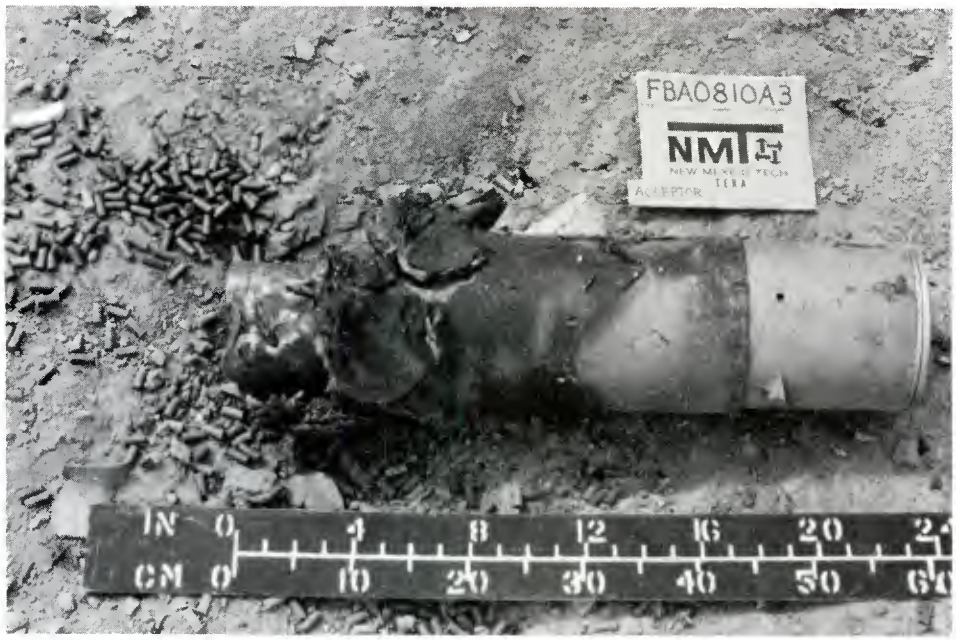
TEST: FBA0810A3
DATE: 10 AUGUST 1983
TIME: 15:18 MDT

ACCEPTOR #1 - STANDOFF NOSE - AFTER TEST

ACCEPTOR #1 - DAMAGED WARHEAD - AFTER TEST

Figure 7e. Test FBA0810A3

TEST: FBA0810A3
DATE: 10 AUGUST 1983
TIME: 15:18 MDT



ACCEPTOR #1 - DAMAGED CARTRIDGE CASE AND SHIPPING TUBE
AFTER TEST

Figure 7f. Test FBA0810A3

TEST: FBA0810A3
DATE: 10 AUGUST 1983
TIME: 15:18 MDT

ACCEPTOR #2 - STANDOFF NOSE - AFTER TEST

ACCEPTOR #2 - DAMAGED WARHEAD - AFTER TEST

Figure 7g. Test FBA0810A3

TEST: FBA0810A3
DATE: 10 AUGUST 1983
TIME: 15:18 MDT

ACCEPTOR #2 - DAMAGED CARTRIDGE CASE AND SHIPPING TUBE AFTER TEST

Figure 7h. Test FBA0810A3

TEST: FBA0830A3
DATE: 30 AUGUST 1983
TIME: 10:50 MDT

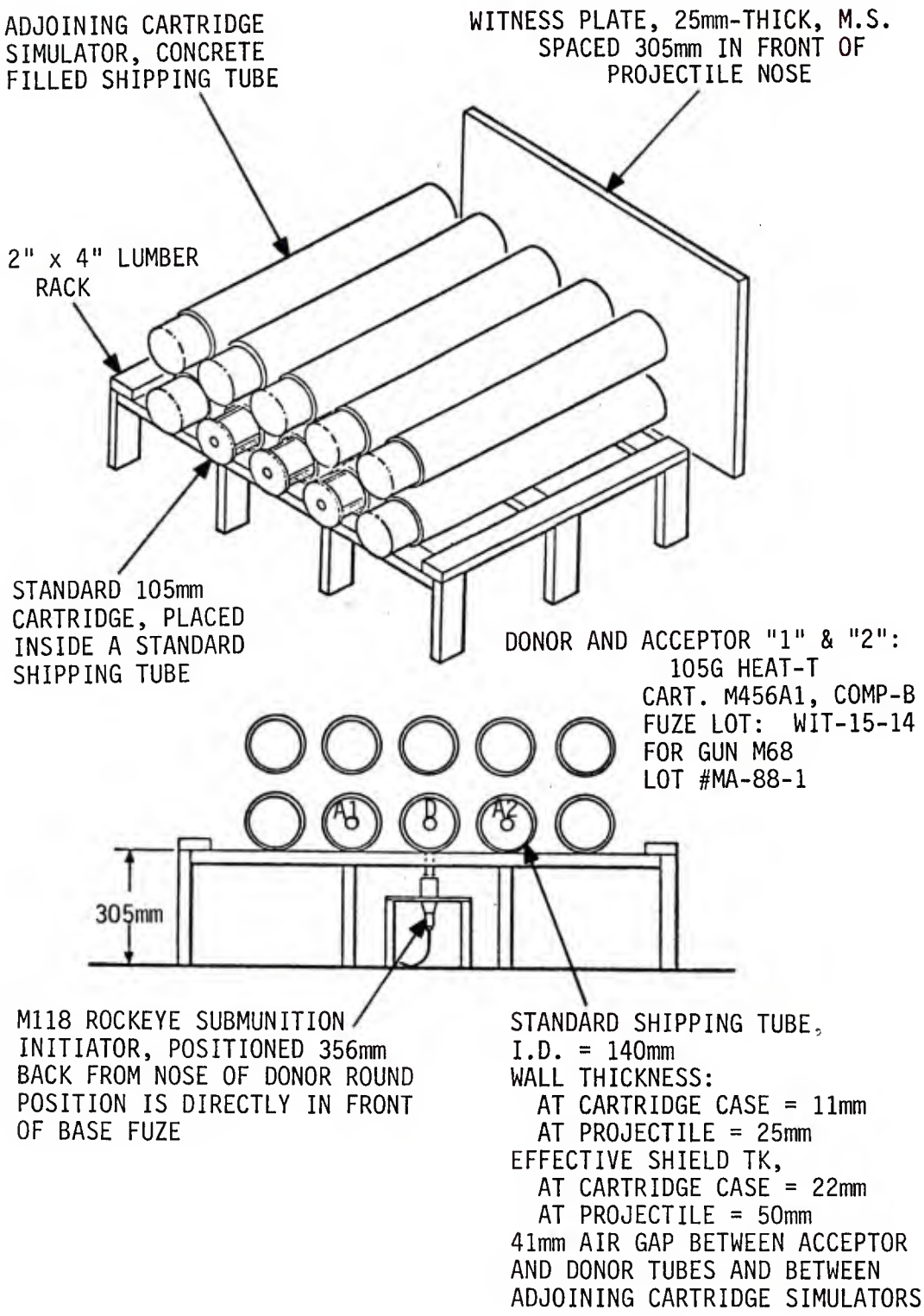
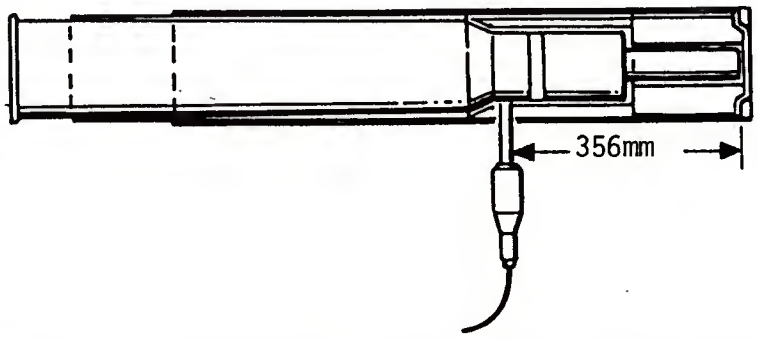


Figure 8a. Test FBA0830A3

TEST: FBA0830A3
DATE: 30 AUGUST 1983
TIME: 10:50 MDT

TYPICAL PLACEMENT OF FIXED CARTRIDGE IN STANDARD SHIPPING TUBE



PLACEMENT OF M118 ROCKEYE FOR DETONATION OF HEAT PROJECTILE. ROCKEYE PLACEMENT WAS JUST FORWARD OF BASE FUZE.

Figure 8b. Test FBA0830A3

TEST: FBA0830A3
DATE: 30 AUGUST 1983
TIME: 10:50 MDT

SIDE VIEW OF SETUP - BEFORE TEST

FRONT VIEW OF TEST SETUP - BEFORE TEST

Figure 8c. Test FBA0830A3

TEST: FBA0830A3
DATE: 30 AUGUST 1983
TIME: 10:50 MDT

DONOR CASE FRAGMENT - AFTER TEST

WITNESS PLATE - AFTER TEST
ONLY APPARENT JET FORMATION WAS FROM DONOR

Figure 8d. Test FBA0830A3

TEST: FBA0830A3
DATE: 30 AUGUST 1983
TIME: 10:50 MDT

ACCEPTOR #1 - WARHEAD FRAGMENT - AFTER TEST

ACCEPTOR #1 - DAMAGED LINER FROM WARHEAD

Figure 8e. Test FBA0830A3

TEST: FBA0830A3
DATE: 30 AUGUST 1983
TIME: 10:50 MDT

ACCEPTOR #2 - STANDOFF NOSE - AFTER TEST

ACCEPTOR #2 - DAMAGED WARHEAD - AFTER TEST

Figure 8f. Test FBA0830A3

TEST: FBA0830A3
DATE: 30 AUGUST 1983
TIME: 10:50 MDT

ACCEPTOR #2 - DAMAGED CARTRIDGE CASE AND SHIPPING TUBE AFTER TEST

Figure 8g. Test FBA0830A3

TEST: FBA0831A3
DATE: 31 AUGUST 1983
TIME: 10:00 MDT

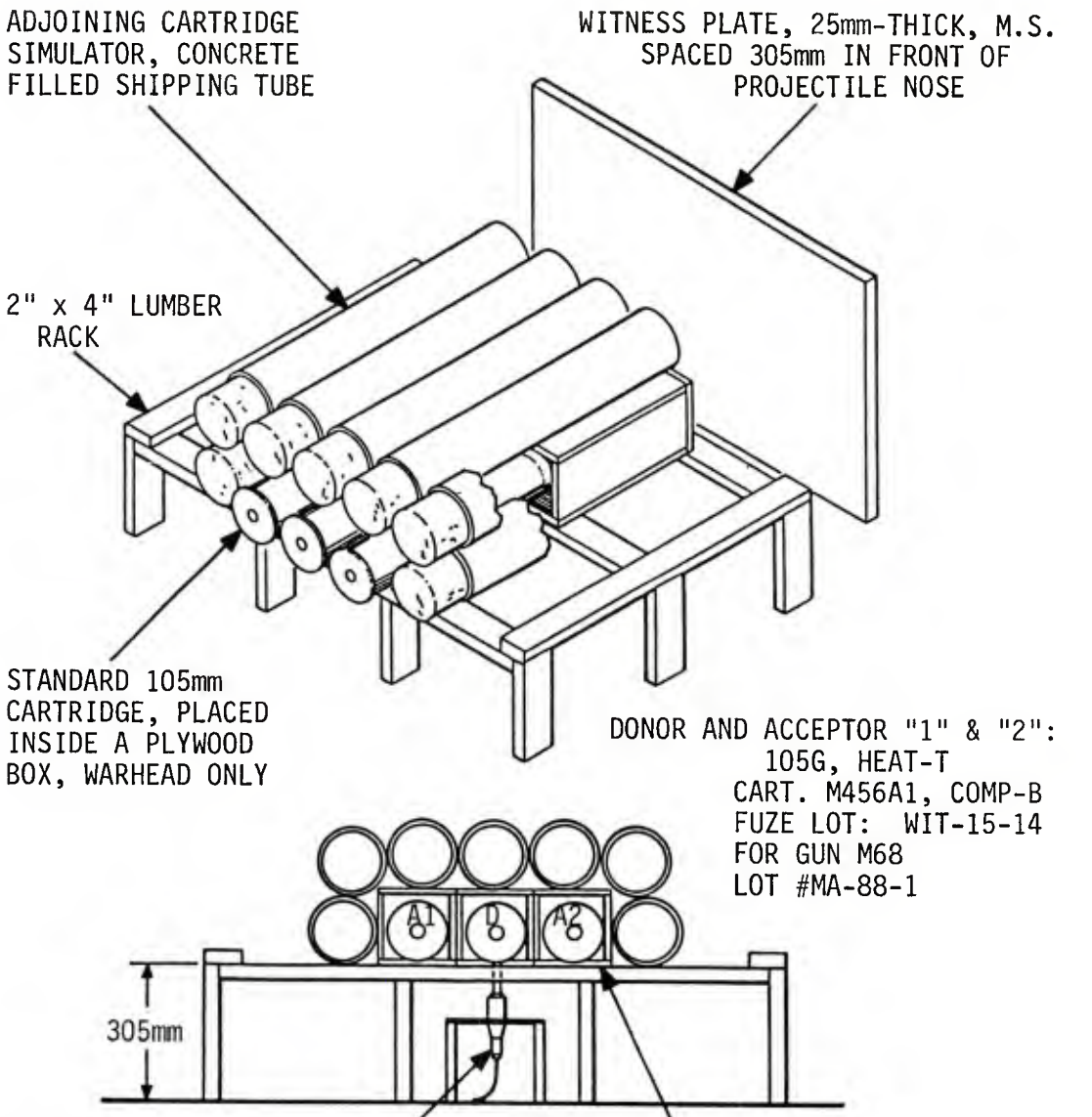
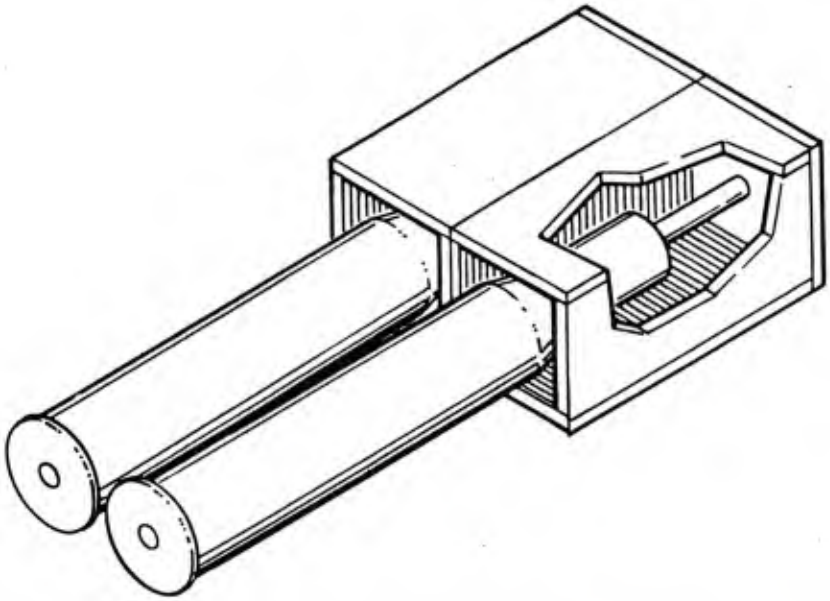
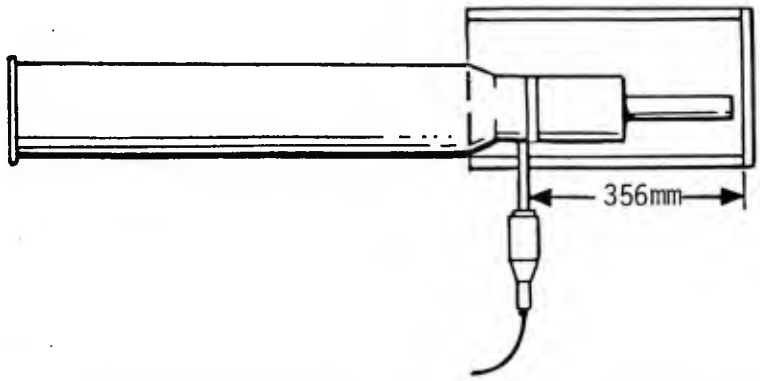


Figure 9a. Test FBA0831A3

TEST: FBA0831A3
DATE: 31 AUGUST 1983
TIME: 10:00 MDT



TYPICAL PLACEMENT OF FIXED CARTRIDGE IN WOOD BOX. WARHEAD ONLY.



PLACEMENT OF M118 ROCKEYE FOR DETONATION OF HEAT PROJECTILE.
ROCKEYE PLACEMENT WAS JUST FORWARD OF BASE FUZE.

Figure 9b. Test FBA0831A3

TEST: FBA0831A3
DATE: 31 AUGUST 1983
TIME: 10:00 MDT

SIDE VIEW OF SETUP - BEFORE TEST

FRONT VIEW OF SETUP - BEFORE TEST

Figure 9c. Test FBA0831A3

TEST: FBA0831A3
DATE: 31 AUGUST 1983
TIME: 10:00 MDT

DONOR CASE FRAGMENT - AFTER TEST

WITNESS PLATE - AFTER TEST

ONLY APPARENT JET FORMATION WAS FROM DONOR PROJECTILE. REACTIONS FROM ACCEPTOR PROJECTILES LEFT INDENTIONS IN WITNESS PLATE, BUT NO EVIDENCE OF JET FORMATION.

Figure 9d. Test FBA0831A3

TEST: FBA0831A3
DATE: 31 AUGUST 1983
TIME: 10:00 MDT

ACCEPTOR #1 - FUZE CAVITY FRAGMENT - AFTER TEST

ACCEPTOR #1 - WARHEAD FRAGMENT - AFTER TEST

Figure 9e. Test FBA0831A3

TEST: FBA0831A3
DATE: 31 AUGUST 1983
TIME: 10:00 MDT

ACCEPTOR #1 - DAMAGED CARTRIDGE CASE - AFTER TEST

Figure 9f. Test FBA0831A3

TEST: FBA0831A3
DATE: 31 AUGUST 1983
TIME: 10:00 MDT

ACCEPTOR #2 - WARHEAD FRAGMENT - AFTER TEST

ACCEPTOR #2 - WARHEAD FRAGMENT - AFTER TEST

Figure 9g. Test FBA0831A3

TEST: FBA0831A3
DATE: 31 AUGUST 1983
TIME: 10:00 MDT

ACCEPTOR #2 - DAMAGED CARTRIDGE CASE AND FUZE CAVITY
AFTER TEST

Figure 9h. Test FBA0831A3

TEST: FBA0831B3
DATE: 31 AUGUST 1983
TIME: 16:50 MDT

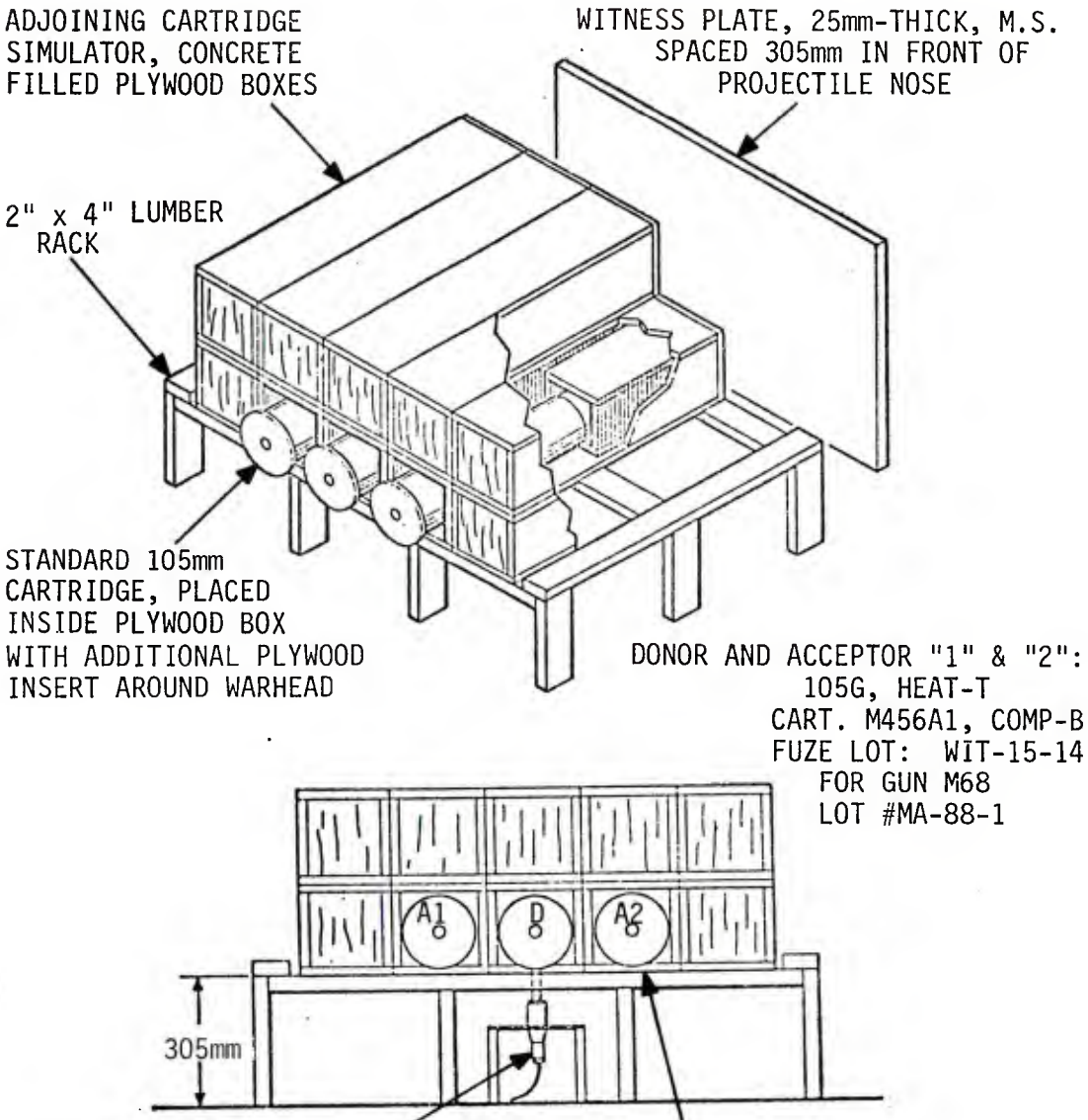
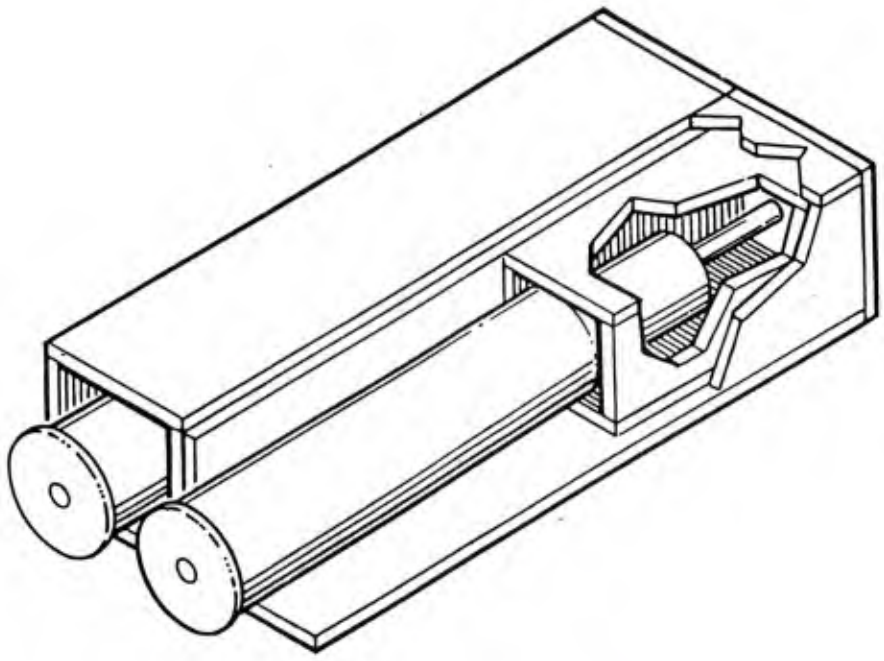
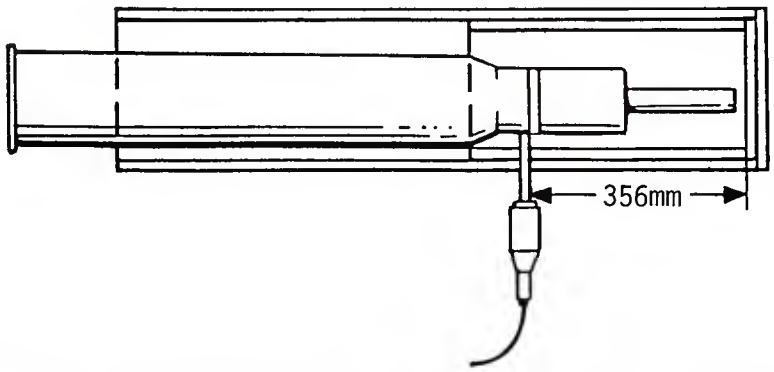


Figure 10a. Test FBA0831B3

TEST: FBA0831B3
DATE: 31 AUGUST 1983
TIME: 16:50 MDT



TYPICAL PLACEMENT OF FIXED CARTRIDGE IN WOOD BOX
WITH WOOD BOX INSERT



PLACEMENT OF M118 ROCKEYE FOR DETONATION OF HEAT PROJECTILE.
ROCKEYE PLACEMENT WAS JUST FORWARD OF BASE FUZE.

Figure 10b. Test FBA0831B3

TEST: FBA0831B3
DATE: 31 AUGUST 1983
TIME: 16:50 MDT

SIDE VIEW OF SETUP - BEFORE TEST

FRONT VIEW OF SETUP - BEFORE TEST

Figure 10c. Test FBA0831B3

TEST: FBA0831B3
DATE: 31 AUGUST 1983
TIME: 16:50 MDT

DONOR CASE FRAGMENT - AFTER TEST

WITNESS PLATE - AFTER TEST
ONLY APPARENT JET FORMATION WAS FROM DONOR PROJECTILE

Figure 10d. Test FBA0831B3

TEST: FBA0831B3
DATE: 31 AUGUST 1983
TIME: 16:50 MDT

ACCEPTOR #1 - STANDOFF NOSE - AFTER TEST

ACCEPTOR #1 - DAMAGED CARTRIDGE CASE AND WARHEAD AFTER TEST

Figure 10e. Test FBA0831B3

TEST: FBA0831B3
DATE: 31 AUGUST 1983
TIME: 16:50 MDT

ACCEPTOR #2 - DAMAGED CARTRIDGE CASE AND WARHEAD
AFTER TEST

Figure 10f. Test FBA0831B3

TEST: FBA0901A3
DATE: 1 SEPTEMBER 1983
TIME: 11:45 MDT

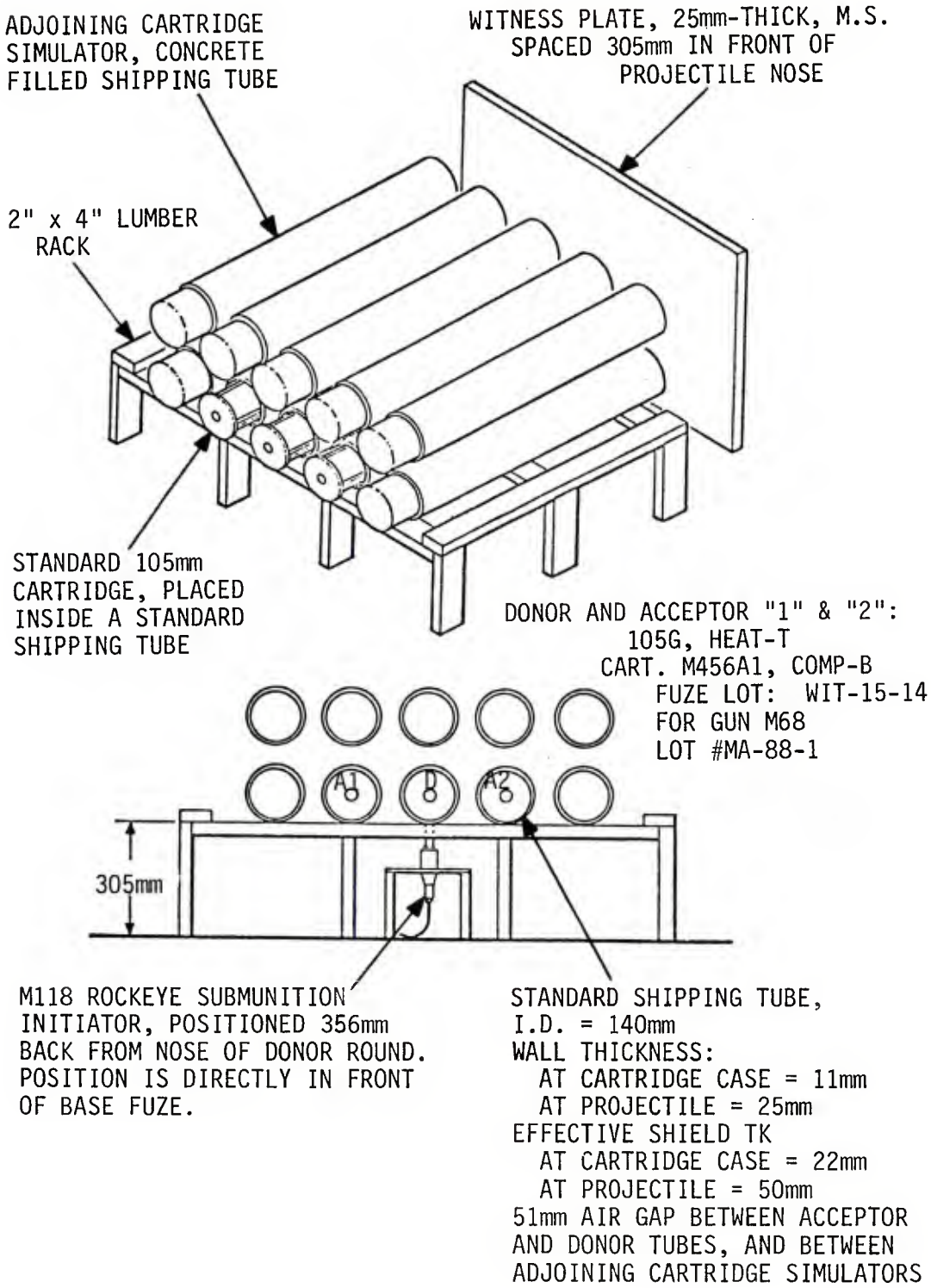
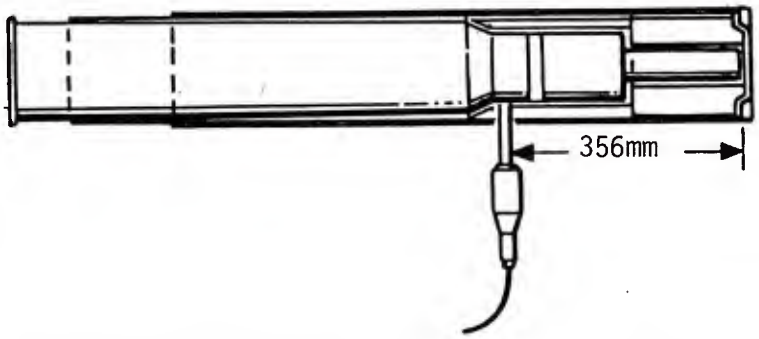


Figure 11a. Test FBA0901A3

TEST: FBA0901A3
DATE: 1 SEPTEMBER 1983
TIME: 11:45 MDT

TYPICAL PLACEMENT OF FIXED CARTRIDGE IN STANDARD SHIPPING TUBE



PLACEMENT OF M118 ROCKEYE FOR DETONATION OF HEAT PROJECTILE. ROCKEYE PLACEMENT WAS JUST FORWARD OF BASE FUZE.

Figure 11b. Test FBA0901A3

TEST: FBA0901A3
DATE: 1 SEPTEMBER 1983
TIME: 11:45 MDT

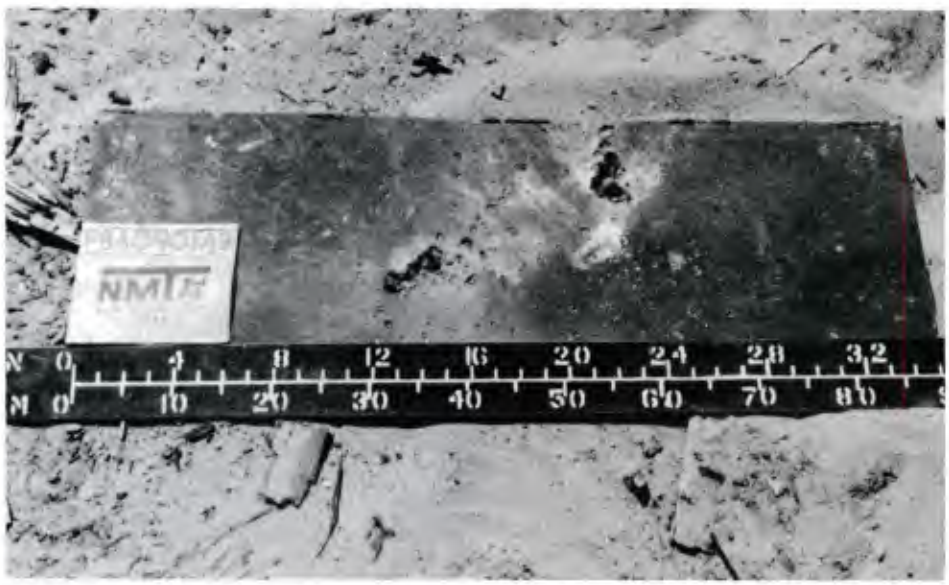
SIDE VIEW OF SETUP - BEFORE TEST

FRONT VIEW OF SETUP - BEFORE TEST

Figure 11c. Test FBA0901A3

TEST: FBA0901A3
DATE: 1 SEPTEMBER 1983
TIME: 11:45 MDT

DONOR CASE FRAGMENT - AFTER TEST



WITNESS PLATE - AFTER TEST
ONLY APPARENT JET FORMATION WAS FROM DONOR

Figure 11d. Test FBA0901A3

TEST: FBA0901A3
DATE: 1 SEPTEMBER 1983
TIME: 11:45 MDT

ACCEPTOR #1 - STANDOFF NOSE - AFTER TEST

ACCEPTOR #1 - DAMAGED WARHEAD - AFTER TEST

Figure 11e. Test FBA0901A3

TEST: FBA0901A3
DATE: 1 SEPTEMBER 1983
TIME: 11:45 MDT

ACCEPTOR #1 - DAMAGED CARTRIDGE CASE AND SHIPPING TUBE
AFTER TEST

Figure 11f. Test FBA0901A3

TEST: FBA0901A3
DATE: 1 SEPTEMBER 1983
TIME: 11:45 MDT

ACCEPTOR #2 - DAMAGED CARTRIDGE CASE, SHIPPING TUBE, AND WARHEAD - AFTER TEST

ACCEPTOR #2 - STANDOFF NOSE - AFTER TEST

Figure 11g. Test FBA0901A3

TEST: FBA1018A3
DATE: 18 OCTOBER 1983
TIME: 15:05 MDT

TEMPORARY TANK AMMUNITION STORAGE FACILITY, WOOD RACK

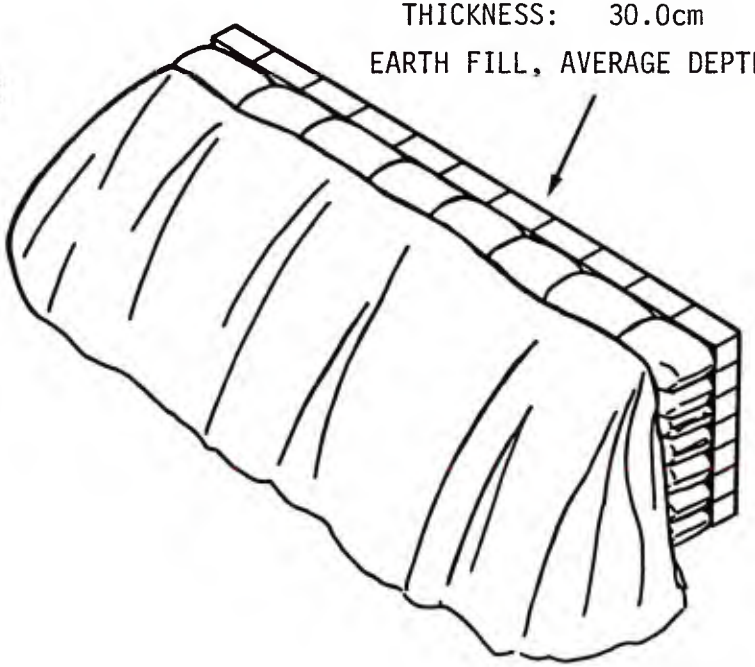
FRONT REVETMENT WALL:
CINDERBLOCK WALL, SANDBAG AND EARTH FILL
NO MORTAR JOINTS INBETWEEN BLOCKS, VOID IN BLOCKS FILLED WITH SAND;

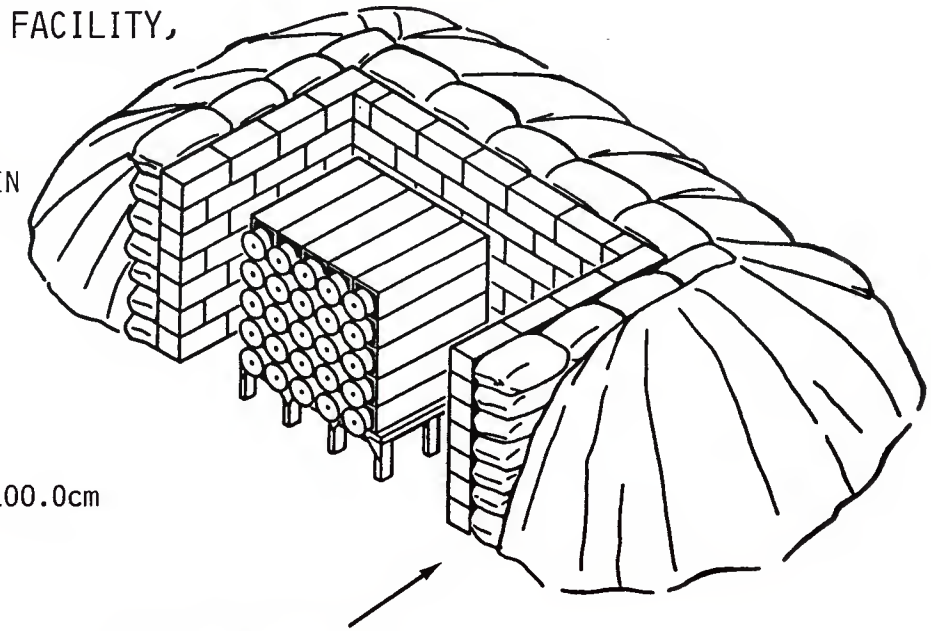
DIMENSIONS:

CINDERBLOCK WALL - LENGTH: 439.4cm
HEIGHT: 137.1cm
THICKNESS: 19.0cm

SANDBAG WALL - LENGTH: 439.4cm
HEIGHT: 137.1cm
THICKNESS: 30.0cm

EARTH FILL, AVERAGE DEPTH: 100.0cm





REVETMENT BUNKER:
OVERALL INSIDE DIMENSIONS - LENGTH: 195.5cm
HEIGHT: 137.1cm
DEPTH: 140.3cm

CONSTRUCTION DETAIL IS SAME AS FRONT REVETMENT WALL

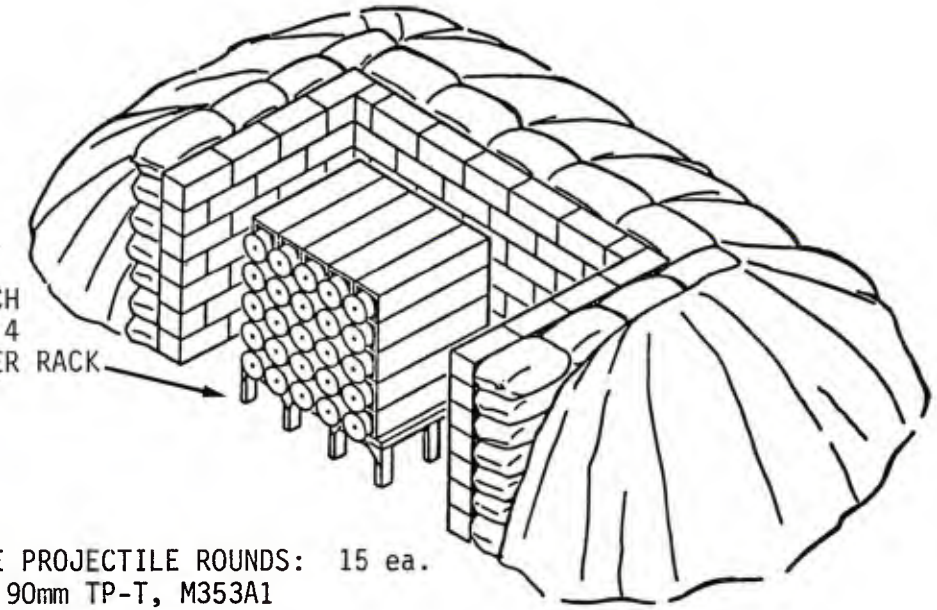
POSITION OF WOOD AMMUNITION RACK:
CENTERED IN REVETMENT BUNKER

AIR GAP TO BACK WALL: 30.4cm
AIR GAP TO SIDE WALLS: 43.8cm
AIR GAP ON BOTTOM: 30.4cm

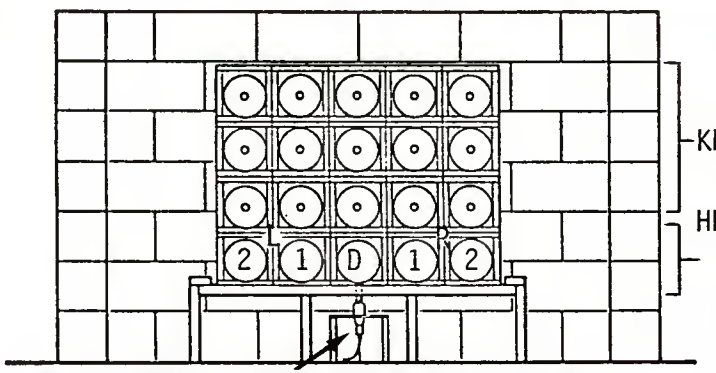
Figure 12a. Test FBA1018A3

TEST: FBA1018A3
DATE: 18 OCTOBER 1983
TIME: 15:05 MDT

TEMPORARY TANK AMMUNITION STORAGE FACILITY.
WOOD RACK



PLYWOOD BOXES:
O.D. = 21.5cm x 21.5cm EACH
BOX, STACKED 5 ACROSS AND 4
ROWS HIGH ON A 2"x4" LUMBER RACK



KE PROJECTILE ROUNDS: 15 ea.
90mm TP-T, M353A1

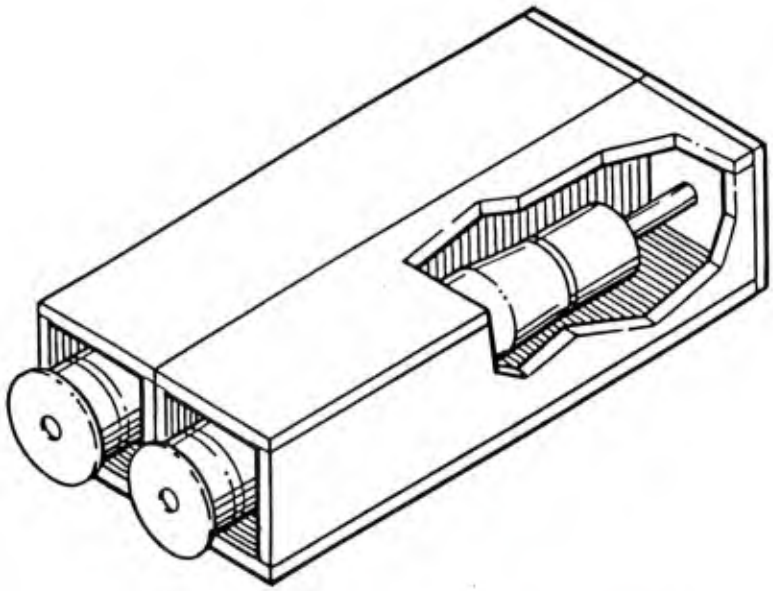
HEAT ROUNDS: 5 ea.
105G, HEAT-T
CART. M456A1, COMP-B
FUZE LOT #WIT-15-14
FOR GUN M68
LOT #MA-88-1

M118 ROCKEYE SUBMUNITION INITIATOR,
POSITIONED 356mm BACK FROM NOSE
OF DONOR ROUND. POSITION IS DIRECTLY
IN FRONT OF BASE FUZE.

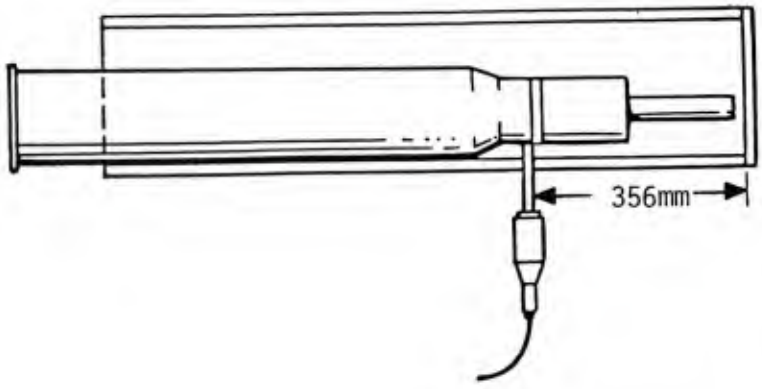
PLYWOOD BOX:
I.D. = 178mm x 178mm
WALL THICKNESS: 19mm
EFFECTIVE SHIELD TK: 38mm
NO AIR GAP BETWEEN BOXES.

Figure 12b. Test FBA1018A3

TEST: FBA1018A3
DATE: 18 OCTOBER 1983
TIME: 15:05 MDT



TYPICAL PLACEMENT OF FIXED CARTRIDGE IN WOODEN BOX

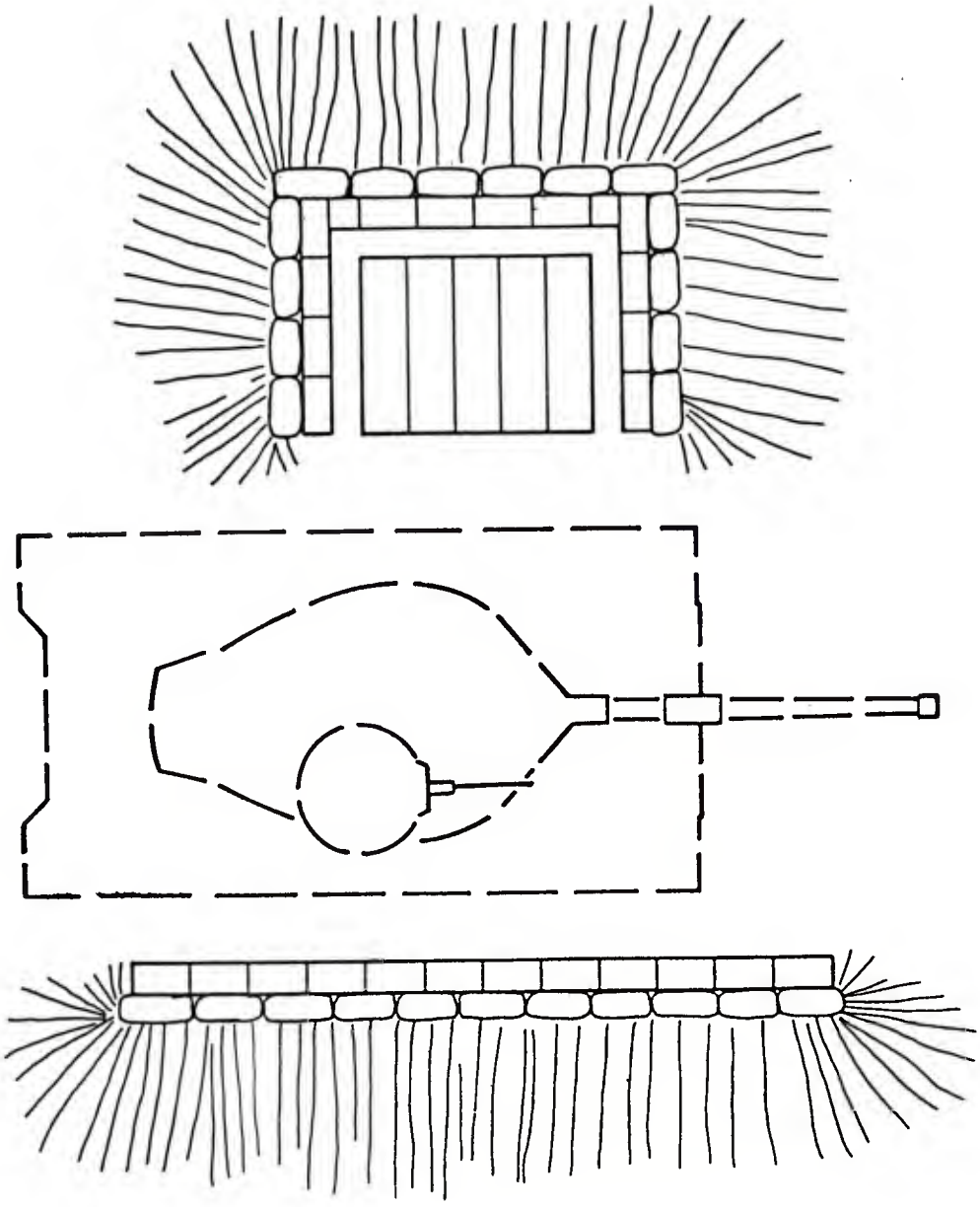


PLACEMENT OF M118 ROCKEYE FOR DETONATION OF HEAT PROJECTILE. ROCKEYE PLACEMENT WAS JUST FORWARD OF BASE FUZE.

Figure 12c. Test FBA1018A3

TEST: FBA1018A3
DATE: 18 OCTOBER 1983
TIME: 15:05 MDT

TEMPORARY TANK AMMO STORAGE FACILITY

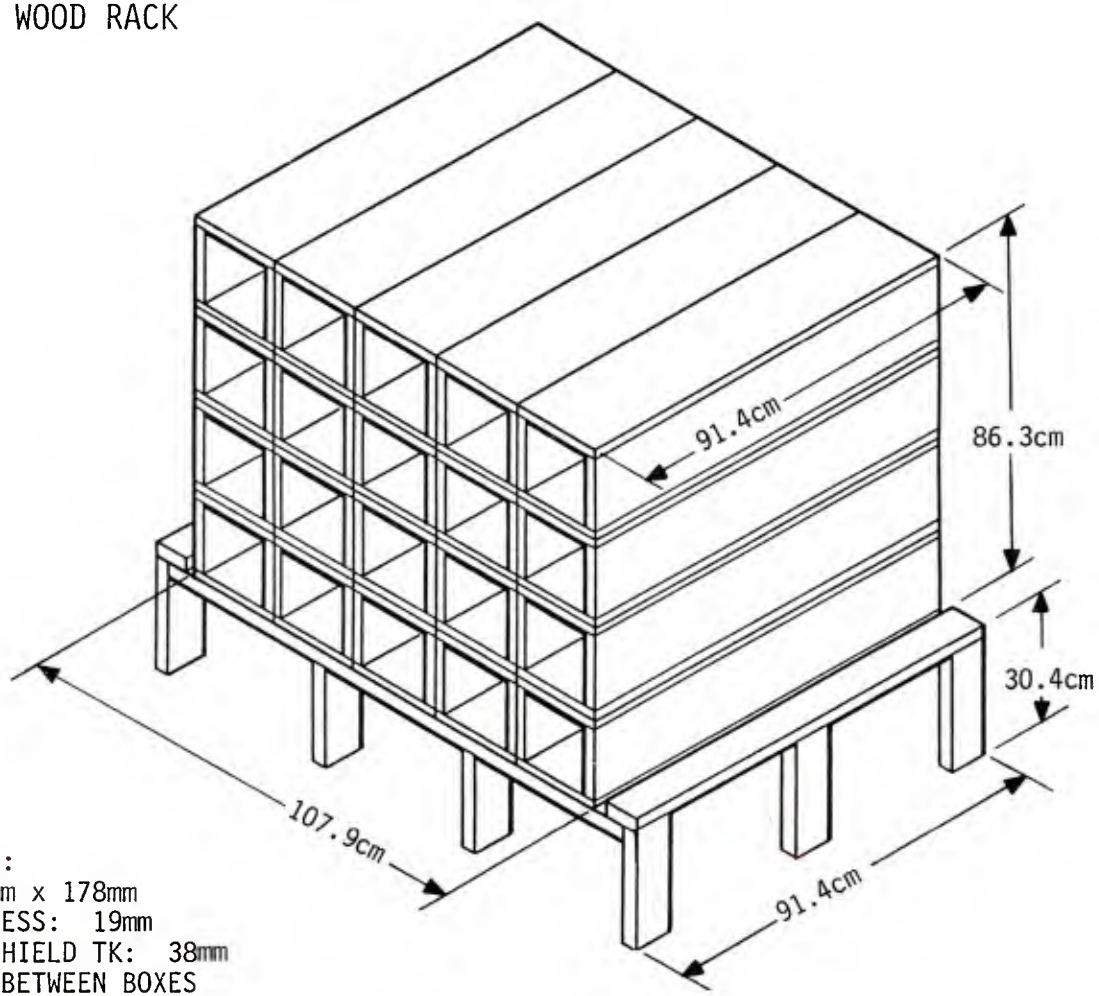


TYPICAL PLACEMENT OF TANK DURING
LOADING/UNLOADING OPERATIONS

Figure 12d. Test FBA1018A3

TEST: FBA1018A3
DATE: 18 OCTOBER 1983
TIME: 15:05 MDT

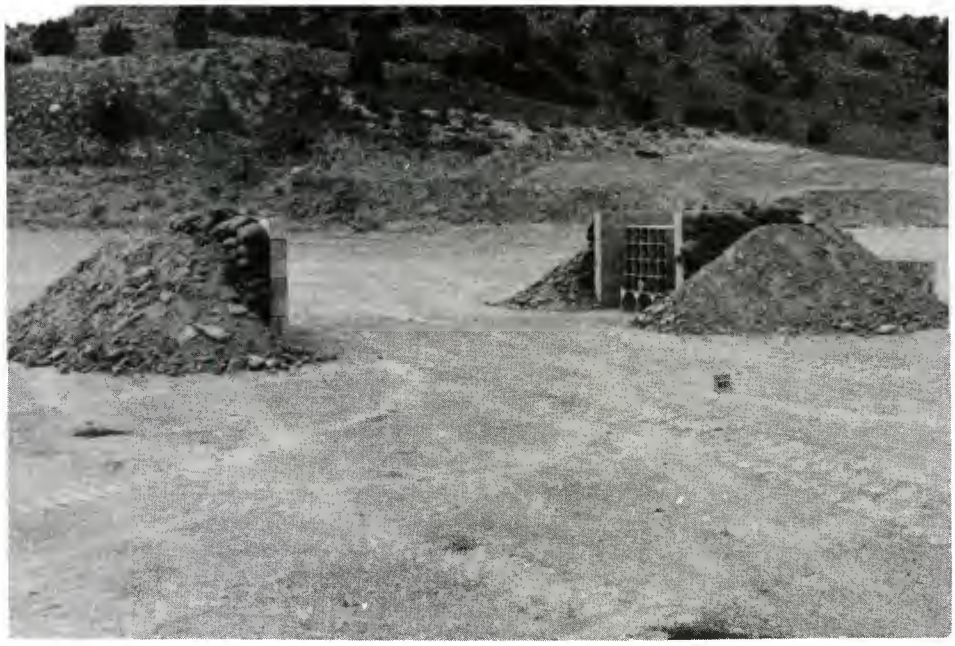
TEMPORARY TANK AMMUNITION STORAGE FACILITY,
WOOD RACK



PLYWOOD BOX:
I.D. = 178mm x 178mm
WALL THICKNESS: 19mm
EFFECTIVE SHIELD TK: 38mm
NO AIR GAP BETWEEN BOXES
4 HIGH x 5 ACROSS

Figure 12e. Test FBA1018A3

TEST: FBA1018A3
DATE: 18 OCTOBER 1983
TIME: 15:05 MDT



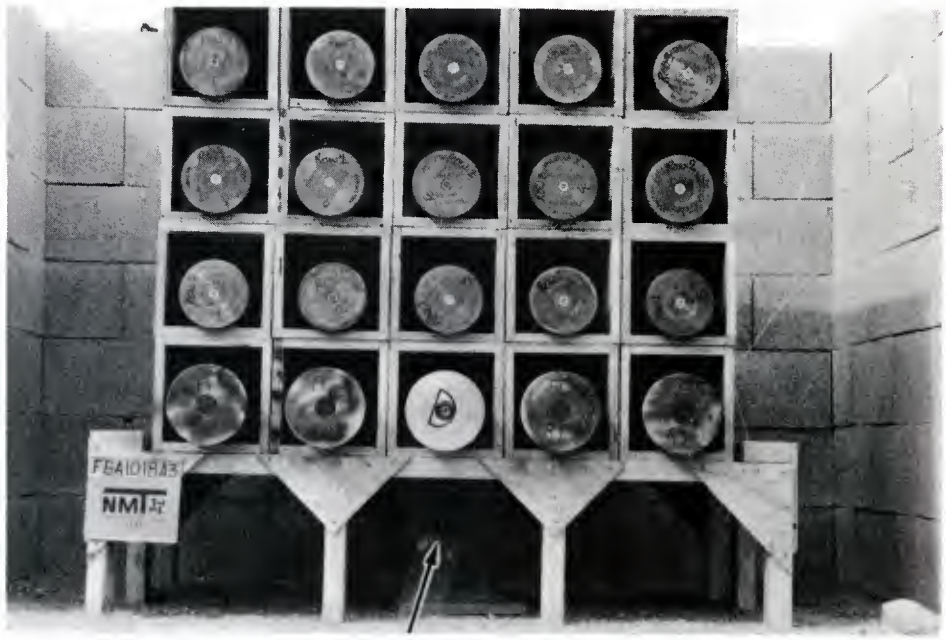
VIEW OF TEMPORARY TANK AMMO STORAGE FACILITY
BEFORE TEST

VIEW OF TEMPORARY TANK AMMO STORAGE FACILITY
SHOWING THE FRONT FACE OF THE REVETMENT WALL ON THE LFFT
BEFORE TEST

Figure 12f. Test FBA1018A3

TEST: FBA1018A3
DATE: 18 OCTOBER 1983
TIME: 15:05 MDT

FRONT VIEW OF SETUP - BEFORE TEST



FRONT VIEW OF SETUP SHOWING ROCKEYE INITIATOR
BEFORE TEST

Figure 12g. Test FBA1018A3

TEST: FBA1018A3
DATE: 18 OCTOBER 1983
TIME: 15:05 MDT

OVERALL VIEW SHOWING DEBRIS LOCATION - AFTER TEST

REAR VIEW SHOWING DEBRIS AND UNDAMAGED WITNESS PANEL
AFTER TEST

PURPOSE OF WITNESS PANEL WAS TO DETERMINE IF REVETMENT WALL WOULD BE PENETRATED BY DONOR JET

Figure 12h. Test FBA1018A3

TEST: FBA1018A3
DATE: 18 OCTOBER 1983
TIME: 15:05 MDT

LEFT VIEW SHOWING DEBRIS AND DAMAGE TO STORAGE FACILITY AFTER TEST

RIGHT VIEW SHOWING DEBRIS AND DAMAGE TO STORAGE FACILITY AFTER TEST

Figure 12i. Test FBA1018A3

TEST: FBA1018A3
DATE: 18 OCTOBER 1983
TIME: 15:05 MDT

FRONT VIEW SHOWING DEBRIS AND DAMAGE TO STORAGE FACILITY AFTER TEST

Figure 12j. Test FBA1018A3

TEST: FBA1018A3
DATE: 18 OCTOBER 1983
TIME: 15:05 MDT

LEFT VIEW SHOWING DEBRIS AND DAMAGE TO REVETMENT WALL

DONOR - DAMAGED CARTRIDGE CASE - AFTER TEST

Figure 12k. Test FBA1018A3

TEST: FBA1018A3
DATE: 18 OCTOBER 1983
TIME: 15:05 MDT

ACCEPTOR #L-1 - DAMAGED CARTRIDGE CASE - AFTER TEST

ACCEPTOR #L-1 - DAMAGED WARHEAD - AFTER TEST

Figure 121. Test FBA1018A3

TEST: FBA1018A3
DATE: 18 OCTOBER 1983
TIME: 15:05 MDT

ACCEPTOR #L-2 - DAMAGED CARTRIDGE CASE AND WARHEAD
AFTER TEST

Figure 12m. Test FBA1018A3

TEST: FBA1018A3
DATE: 18 OCTOBER 1983
TIME: 15:05 MDT

ACCEPTOR #R-1 - DAMAGED CARTRIDGE CASE - AFTER TEST

ACCEPTOR #R-1 - DAMAGED WARHEAD - AFTER TEST

Figure 12n. Test FBA1018A3

TEST: FBA1018A3
DATE: 18 OCTOBER 1983
TIME: 15:05 MDT

ACCEPTOR #R-2 - CARTRIDGE CASE FRAGMENT - AFTER TEST

ACCEPTOR #R-2 - DAMAGED WARHEAD - AFTER TEST

Figure 12o. Test FBA1018A3

TEST: FBA1018A3
DATE: 18 OCTOBER 1983
TIME: 15:05 MDT

K.E. ROUNDS - VIEW OF TYPICAL POST-FIRING DEBRIS

Figure 12p. Test FBA1018A3

TEST: FBA1018A3
DATE: 18 OCTOBER 1983
TIME: 15:05 MDT

K.E. ROUNDS - VIEW OF TYPICAL POST-FIRING DEBRIS

Figure 12q. Test FBA1018A3

TEST: FBA1018A3
DATE: 18 OCTOBER 1983
TIME: 15:05 MDT

Δ - CARTRIDGE CASE
o - KE PROJECTILE
□ - HEAT PROJECTILE
Δ□ - COMPLETE HEAT ROUND
Δo - COMPLETE KE ROUND

TEMPORARY TANK AMMO STORAGE FACILITY
WOOD RACK

DEBRIS RECOVERY ZONES

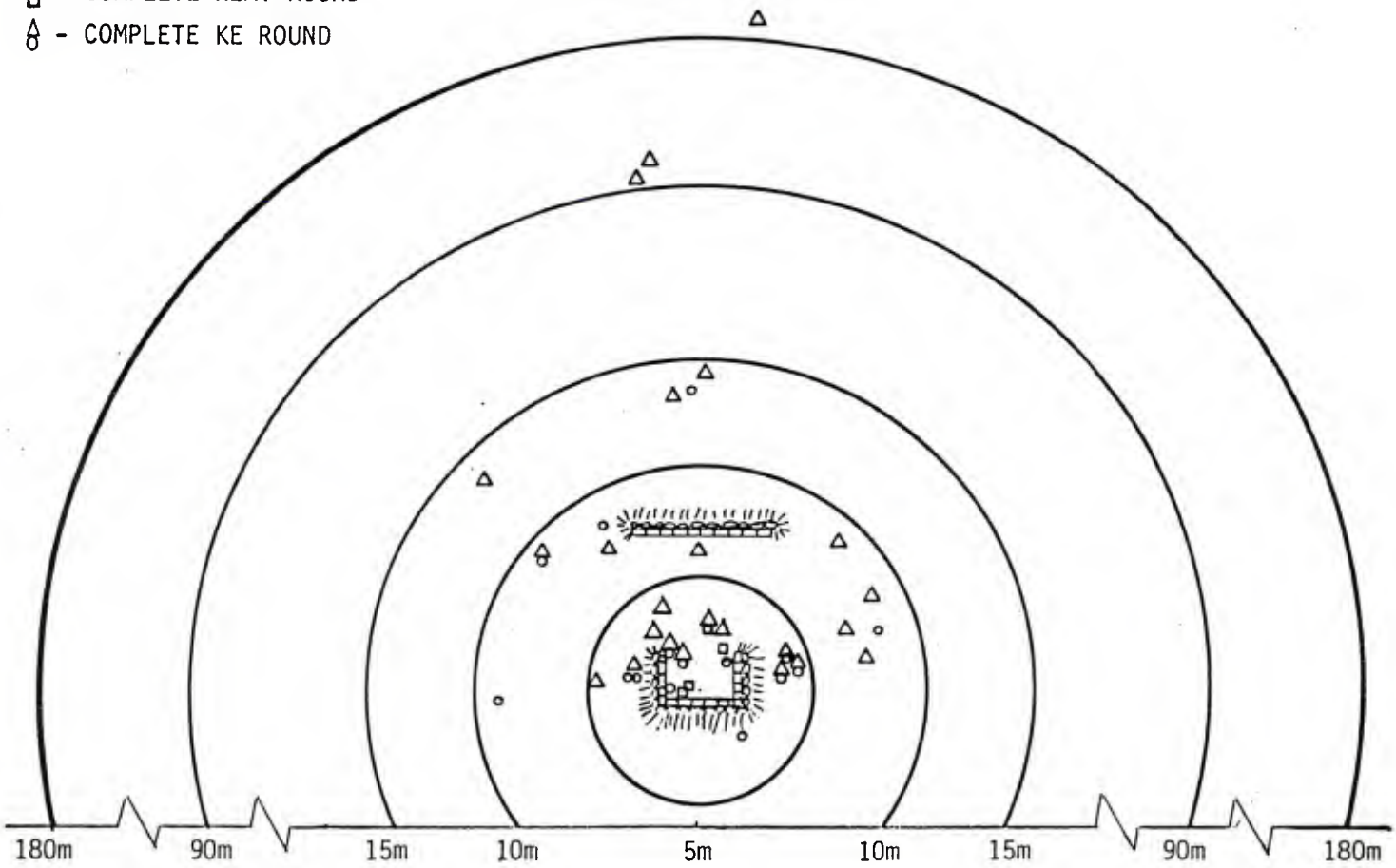


Figure 12r. Test FBA1018A3

TEST: FBA1018A3
DATE: 18 OCTOBER 1983
TIME: 15:05 MDT

TABLE 3. TEMPORARY TANK AMMO STORAGE FACILITY WOOD RACK

DEBRIS RECOVERY

ALL MEASUREMENTS ARE TAKEN FROM POINT OF ROCKEYE INITIATION OF DONOR WARHEAD

5m Radius of Ground Zero	-	3 Acceptor Heat Warheads - 5 KE Projectiles 1 Acceptor, Complete Round - 5 KE, Complete Round - 5 Cartridge Cases
5m - 10 m Zone	-	3 KE Projectiles - 1 KE, Complete Round 6 Cartridge Cases
10m - 15m Zone	-	1 KE Projectile - 3 Cartridge Cases
15m - 90m Zone	-	None
90m - 180m	-	2 Cartridge Case Fragments from R-2, Size: 254mm x 154mm, One at 94.1m, the second at 95.7m.
180m - Zone	-	1 Cartridge Case Fragment, Base and a 195mm x 110mm Section of side attached at 182.8m.

TEST: FBA1021A3
DATE: 21 OCTOBER 1983
TIME: 11:52 MDT

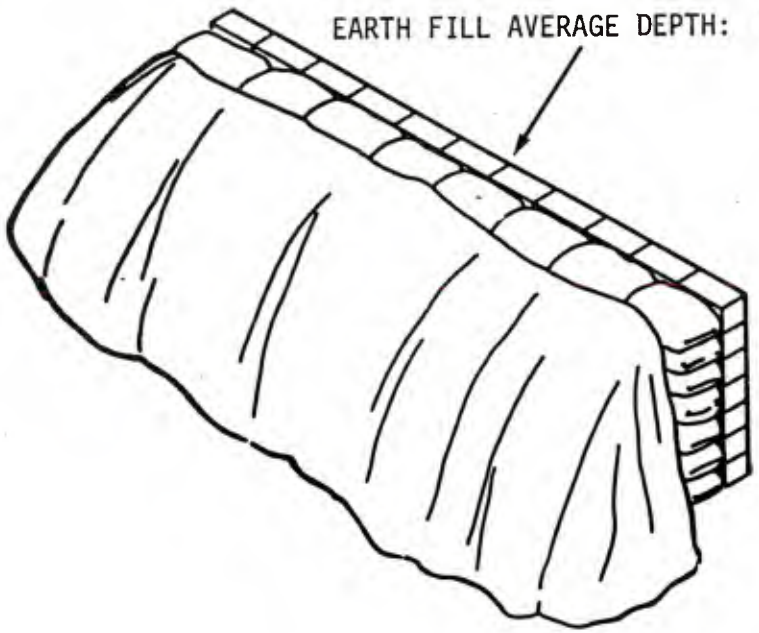
TEMPORARY TANK AMMUNITION STORAGE FACILITY,
STEEL RACK

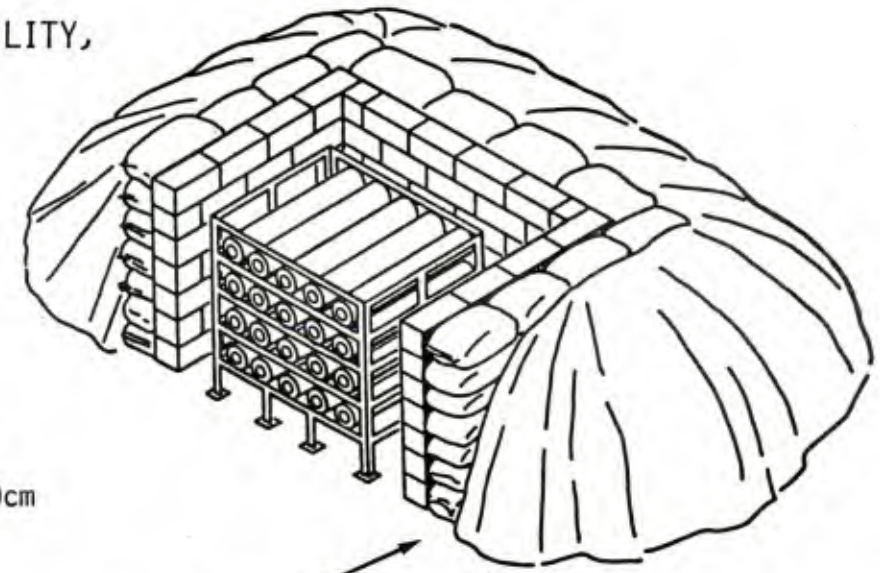
FRONT REVETMENT WALL:
CINDERBLOCK WALL, SANDBAG AND EARTH FILL
NO MORTAR JOINTS INBETWEEN BLOCKS, VOID IN
BLOCKS FILLED WITH SAND

DIMENSIONS:
CINDERBLOCK WALL - LENGTH: 439.4cm
HEIGHT: 137.1cm
THICKNESS: 19.0cm

SANDBAG WALL - LENGTH: 439.4cm
HEIGHT: 137.1cm
THICKNESS: 30.0cm

EARTH FILL AVERAGE DEPTH: 100.0cm





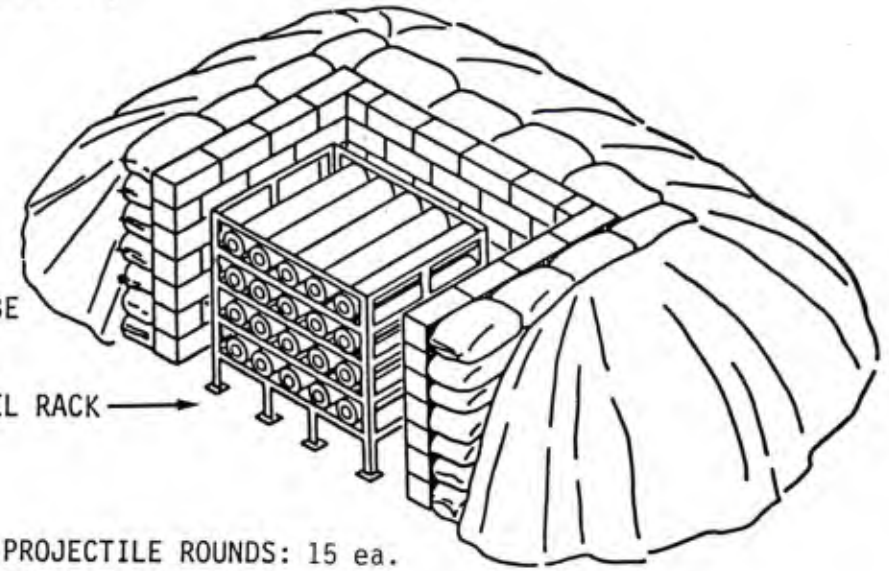
REVETMENT BUNKER:
OVERALL INSIDE DIMENSIONS - LENGTH: 195.5cm
HEIGHT: 137.1cm
DEPTH: 140.3cm

POSITION OF STEEL AMMUNITION RACK:
CENTERED IN REVETMENT BUNKER
AIR GAP FROM RACK TO BACK WALL: 30.4cm
AIR GAP FROM TUBES TO BACK WALL: 30.4cm
AIR GAP FROM RACK TO SIDE WALLS: 31.7cm
AIR GAP FROM TUBES TO SIDE WALLS: 44.4cm
AIR GAP ON BOTTOM: 30.4cm

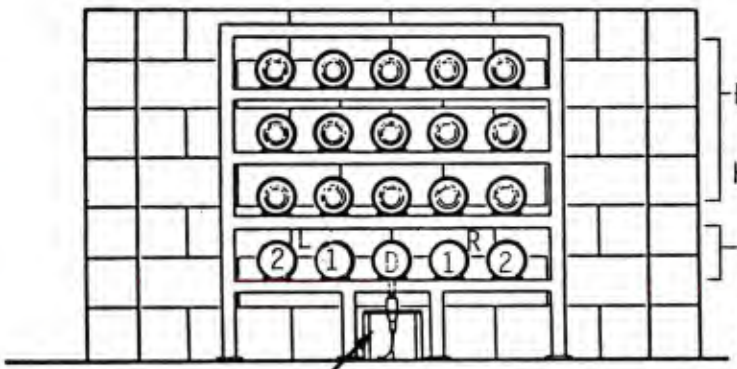
Figure 13a. Test FBA1021A3

TEST: FBA1021A3
DATE: 21 OCTOBER 1983
TIME: 11:52 MDT

TEMPORARY TANK AMMUNITION STORAGE FACILITY,
STEEL RACK



STANDARD SHIPPING TUBE
O.D. = 15.8cm
STACKED 5 ACROSS AND
4 ROWS HIGH ON STEEL RACK



KE PROJECTILE ROUNDS: 15 ea.
90mm TP-T, M353A1

HEAT ROUNDS: 5 ea.
105G, HEAT-T
CART. M456A1, COMP-B
FUZE LOT #WIT-15-14
FOR GUN M68
LOT #MA088-1

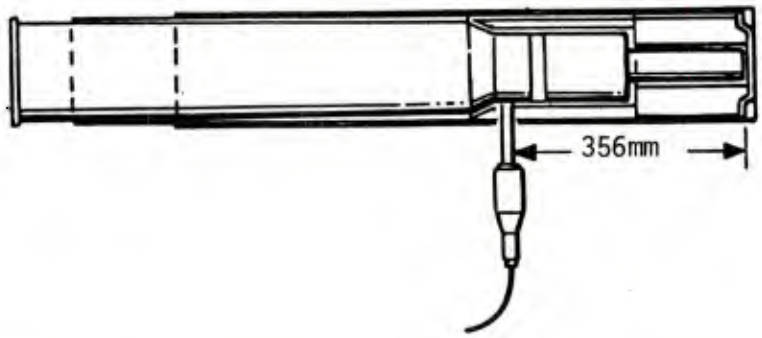
M118 ROCKEYE SUBMUNITION INITIATOR
POSITIONED 356mm BACK FROM NOSE
OF DONOR ROUND. POSITION IS DIRECTLY
IN FRONT OF BASE FUZE.

STANDARD SHIPPING TUBE:
I.D. = 140mm
WALL THICKNESS:
AT CARTRIDGE CASE = 11mm
AT PROJECTILE = 25mm
EFFECTIVE SHIELD TK:
AT CARTRIDGE CASE = 22mm
AT PROJECTILE = 50mm
AIR GAP BETWEEN TUBES:
HORIZONTAL - 70mm
VERTICAL - 95mm

Figure 13b. Test FBA1021A3

TEST: FBA1021A3
DATE: 21 OCTOBER 1983
TIME: 11:52 MDT

TYPICAL PLACEMENT OF FIXED CARTRIDGE IN STANDARD SHIPPING TUBE

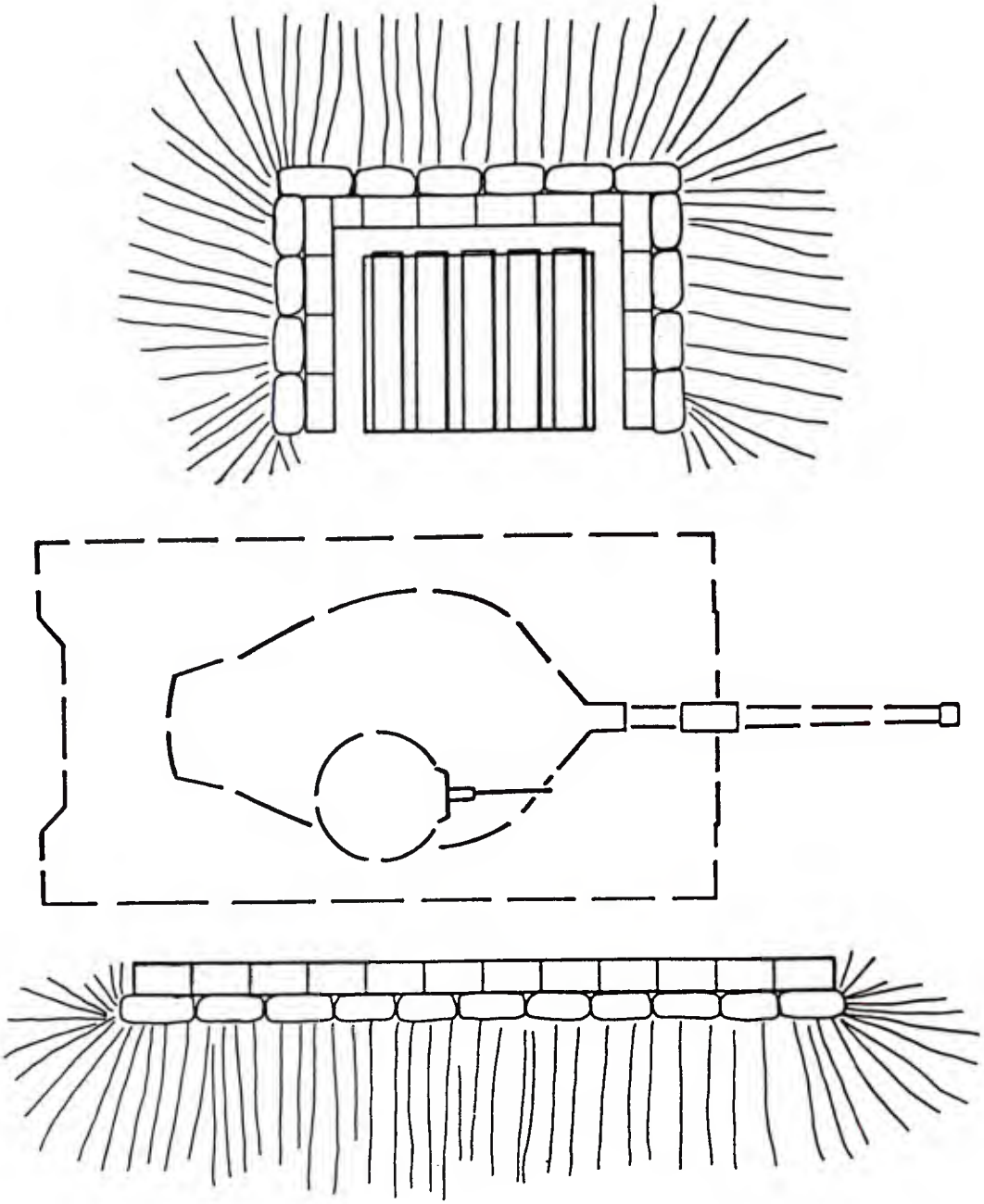


PLACEMENT OF M118 ROCKEYE FOR DETONATION OF HEAT PROJECTILE. ROCKEYE PLACEMENT WAS JUST FORWARD OF BASE FUZE.

Figure 13c. Test FBA1021A3

TEST: FBA1021A3
DATE: 21 OCTOBER 1983
TIME: 11:52 MDT

TEMPORARY TANK AMMO STORAGE FACILITY



TYPICAL PLACEMENT OF TANK DURING
LOADING/UNLOADING OPERATIONS

Figure 13d. Test FBA1021A3

TEST: FBA1021A3
DATE: 21 OCTOBER 1983
TIME: 11:52 MDT

TEMPORARY TANK AMMUNITION STORAGE FACILITY
STEEL RACK

MATERIAL:

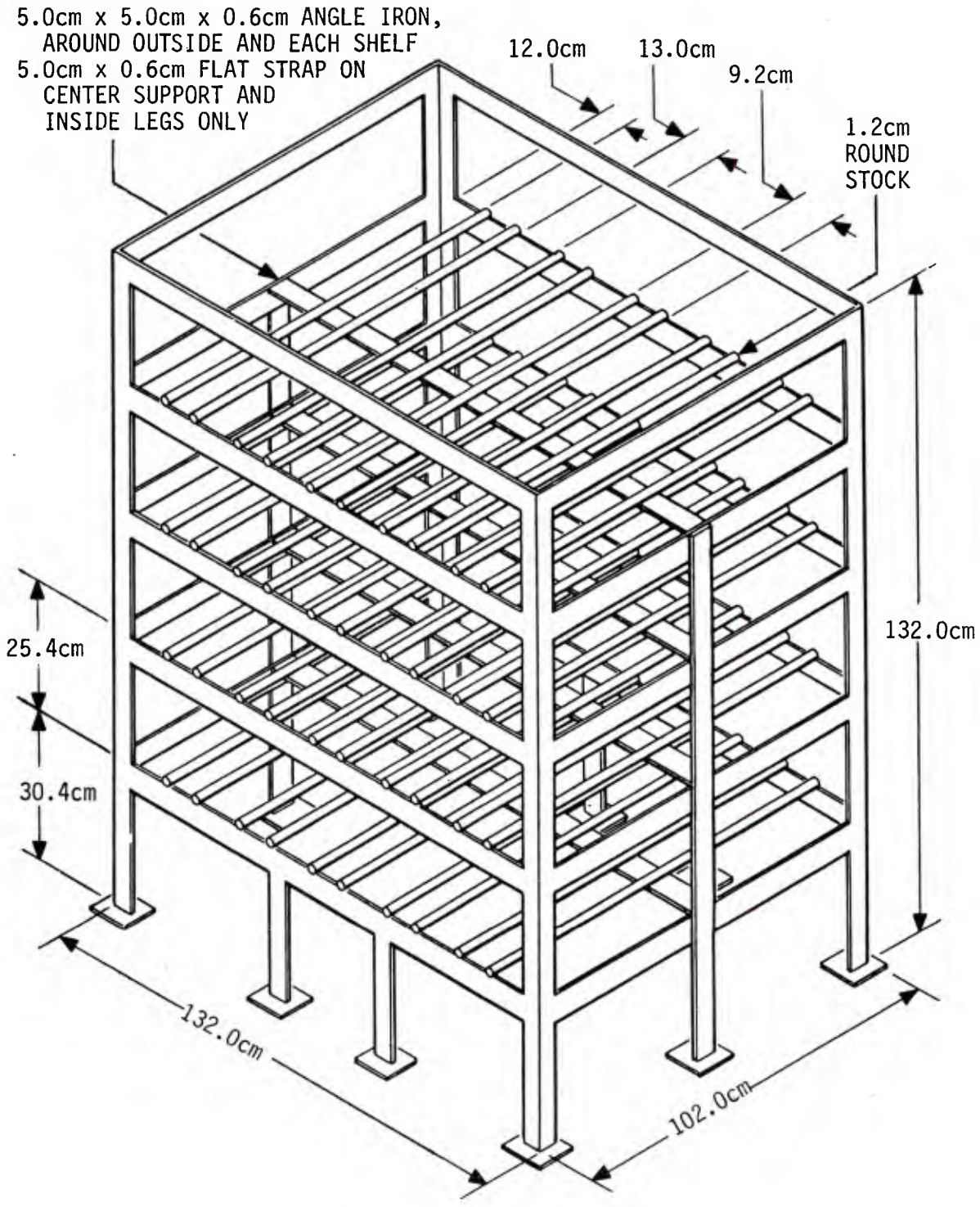


Figure 13e. Test FBA1021A3

TEST: FBA1021A3
DATE: 21 OCTOBER 1983
TIME: 11:52 MDT

TABLE 4. TEMPORARY TANK AMMO STORAGE FACILITY STEEL RACK

DEBRIS RECOVERY

ALL MEASUREMENTS TAKEN FROM POINT OF ROCKEYE INITIATION OF DONOR WARHEAD

5m Radius of Ground Zero	-	3 HEAT Warheads - 9 KE Projectiles - 15 Cartridge Cases
5m - 20m Zone	-	6 KE Projectiles - 1 Cartridge Case Fragment (base only)
20m - 30m Zone	-	1 Cartridge Case - 2 Cartridge Case Fragments, 10cm x 5 cm and 20cm x 10 cm
30m - 40m Zone	-	1 HEAT Warhead (33.8m) - 1 HEAT Fuze (34.4m) - 2 Cartridge Case Fragments, 36cm x 10cm and 42cm x 8cm (30.1m)
40m - 50m Zone	-	1 Cartridge Case Fragment (42.9m)
50m - 60m Zone	-	1 Cartridge Case (56.3m) - 1 Cartridge Case Fragment, 4cm x 6cm (59.1m)

TEST: FBA1021A3
DATE: 21 OCTOBER 1983
TIME: 11:52 MDT

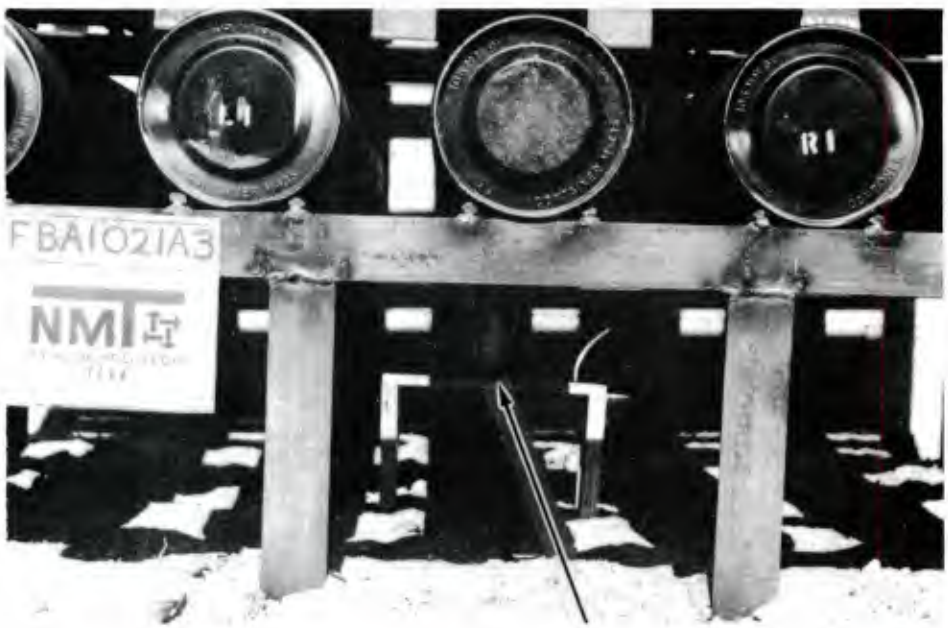
VIEW OF TEMPORARY TANK AMMO STORAGE FACILITY - BEFORE TEST

VIEW SHOWING REVETMENT WALL - BEFORE TEST

Figure 13f. Test FBA1021A3

TEST: FBA1021A3
DATE: 21 OCTOBER 1983
TIME: 11:52 MDT

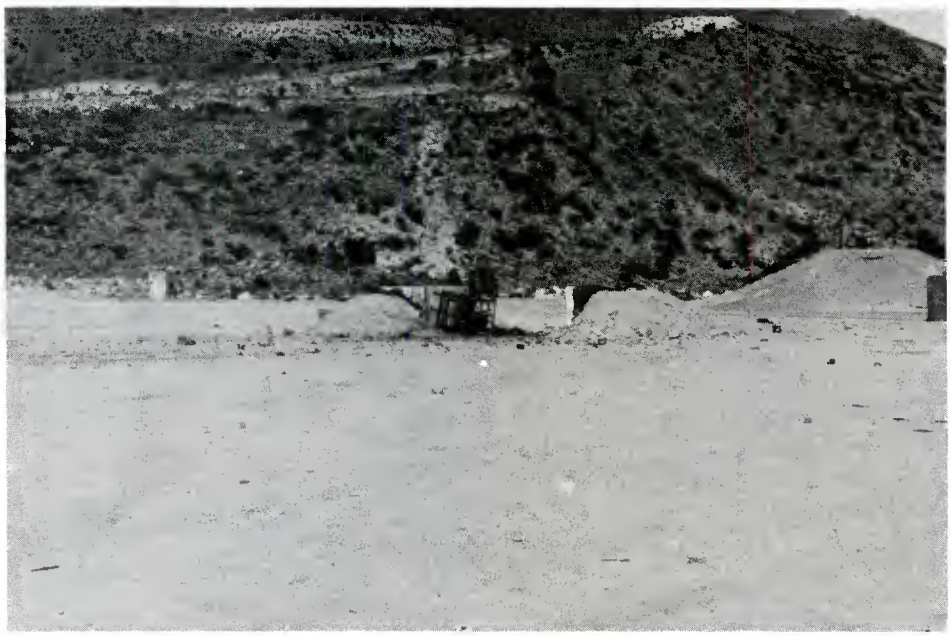
FRONT VIEW OF SETUP - BEFORE TEST



CLOSEUP FRONT VIEW OF SETUP SHOWING ROCKEYE INITIATOR
BEFORE TEST

Figure 13g. Test FBA1021A3

TEST: FBA1021A3
DATE: 21 OCTOBER 1983
TIME: 11:52 MDT



LEFT SIDE OVERALL VIEW SHOWING DEBRIS IN TEST AREA
AFTER TEST

RIGHT SIDE OVERALL VIEW SHOWING DEBRIS IN TEST AREA
AFTER TEST

Figure 13h. Test FBA1021A3

TEST: FBA1021A3
DATE: 21 OCTOBER 1983
TIME: 11:52 MDT

RIGHT SIDE CLOSEUP VIEW SHOWING TYPICAL DEBRIS
AND DAMAGE TO STORAGE FACILITY - AFTER TEST

LEFT SIDE CLOSEUP VIEW SHOWING TYPICAL DEBRIS
AND DAMAGE TO STORAGE FACILITY - AFTER TEST

Figure 13i. Test FBA1021A3

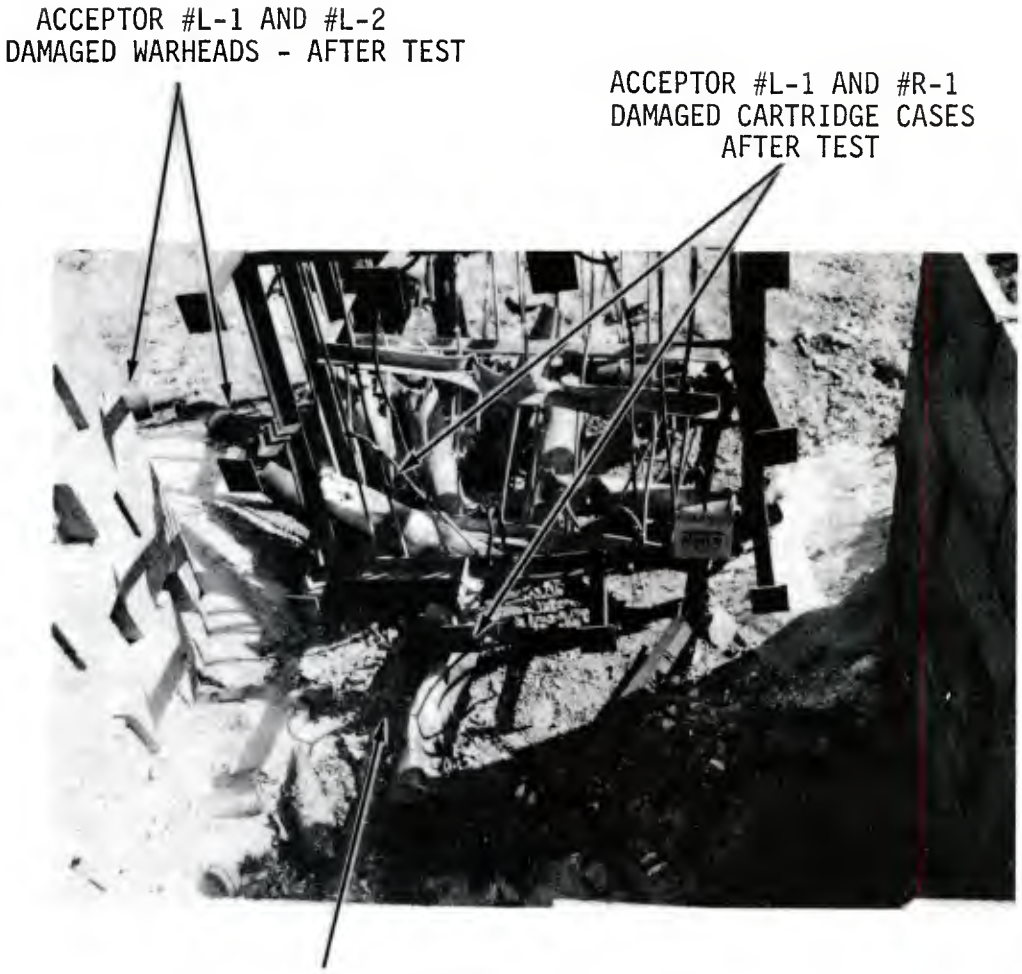
TEST: FBA1021A3
DATE: 21 OCTOBER 1983
TIME: 11:52 MDT

REVETMENT WALL SHOWING DAMAGE - AFTER TEST

DONOR - DAMAGED CARTRIDGE CASE - AFTER TEST

Figure 13j. Test FBA1021A3

TEST: FBA1021A3
DATE: 22 OCTOBER 1983
TIME: 11:52 MDT



ACCEPTOR #L-1, #L-2, #R-1 - DAMAGED WARHEADS AND CARTRIDGE CASES AFTER TEST

Figure 13k. Test FBA1021A3

TEST: FBA1021A3
DATE: 21 OCTOBER 1983
TIME: 11:52 MDT

ACCEPTOR #L-1 - DAMAGED WARHEAD - AFTER TEST

ACCEPTOR #L-2 - DAMAGED WARHEAD - AFTER TEST

Figure 131. Test FBA1021A3

TEST: FBA1021A3
DATE: 21 OCTOBER 1983
TIME: 11:52 MDT

ACCEPTOR #R-2 - DAMAGED WARHEAD AND SHIPPING TUBE
AFTER TEST

ACCEPTOR #R-2 - CARTRIDGE CASE FRAGMENT - AFTER TEST

Figure 13m. Test FBA1021A3

TEST: FBA1021A3
DATE: 21 OCTOBER 1983
TIME: 11:52 MDT

K.E. ROUNDS - PROJECTILES SHOWING TYPICAL POST-TEST DAMAGE

Figure 13n. Test FBA1021A3

TEST: FBA1021A3
DATE: 21 OCTOBER 1983
TIME: 11:52 MDT

K.E. ROUNDS - TYPICAL CARTRIDGE CASE FRAGMENTS
SHOWING POST-TEST DAMAGE

Figure 13o. Test FBA1021A3

TEST: FBA1021A3
DATE: 21 OCTOBER 1983
TIME: 11:52 MDT

TEMPORARY TANK AMMO STORAGE FACILITY
STEEL RACK

DEBRIS RECOVERY ZONES

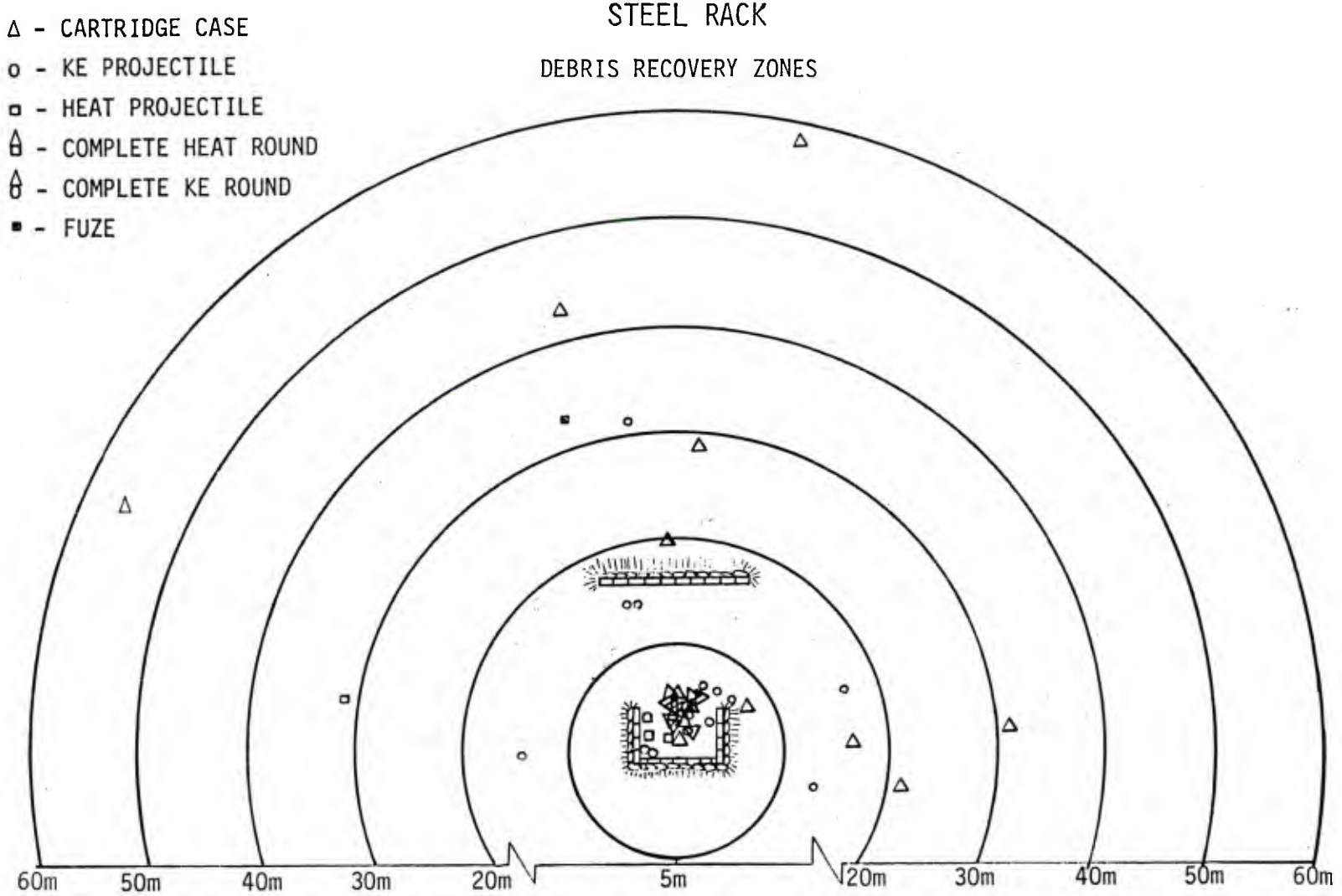


Figure 13p. Test FBA1021A3

DISTRIBUTION LIST

No. of Copies	Organization
12	Administrator Defense Technical Info Center ATTN: DTIC-DDA Cameron Station Alexandria, VA 22314
1	HQDA DAMA-ART-M Washington, DC 20310
5	Chairman DOD Explosives Safety Board ATTN: Dr. T. Zaker COL O. Westry Room 856-C Hoffman Bldg 1 2461 Eisenhower Avenue Alexandria, VA 22331
1	Under Secretary of Defense for Research & Engineering Department of Defense Washington, DC 20301
1	Assistant Secretary of Defense (MI&L) ATTN: EO&SP Washington, DC 20301
1	Chief of Research, Development, & Acquisition Department of the Army ATTN: DAMA-CMS-CA, Mr. Lippi Washington, DC 20310
1	HQDA (DAMO-NC) ATTN: COL R. D. Orton Washington, DC 20310
1	HQDA (DCSLOG) ATTN: Elliot Seard Room 1D563, Pentagon Washington, DC 20310
1	Commander US Army Development & Employment Agency ATTN: MODE-TED-SAB Fort Lewis, WA 98433
2	Assistant Secretary of Army (I&L) Department of the Army ATTN: Lewis D. Walker John Nash Room 3E606, Pentagon Washington, DC 20310
1	Commander USA Safety Center ATTN: PESC-Z Fort Rucker, AL 36360
1	Commander US Army Materiel Command ATTN: AMCDRA-ST 5001 Eisenhower Avenue Alexandria, VA 22333
1	Commander US Army Materiel Command ATTN: AMCSF 5001 Eisenhower Avenue Alexandria, VA 22333
1	Director AMC Field Safety Activity Charlestown, IN 47111-9669
1	HQDA (DAPE-HRS) Washington, DC 20310
1	Chief of Engineers Department of the Army ATTN: DAEN-RDL, Mr. A. E. Simonini Washington, DC 20314
1	Chief of Engineers Department of the Army ATTN: DAZEN-RDZ-A, Dr. J. Choromokos Washington, DC 20314
1	Chief of Engineers Department of the Army ATTN: DAEN-ECE-T, Mr. R. L. Wight Washington, DC 20314
1	New Mexico Institute of Mining Technology ATTN: TERA, David Collis Socorro, NM 87801

DISTRIBUTION LIST

No. of Copies	Organization
1	Commander Armament R&D Center US Army AMCCOM ATTN: SMCAR-TDC Dover, NJ 07801
1	Commander Armament R&D Center US Army AMCCOM ATTN: SMCAR-TSS Dover, NJ 07801-5001
1	Commander Armament R&D Center US Army AMCCOM ATTN: SMCAR-LCM-SP Dover, NJ 07801
1	Commander Armament R&D Center US Army AMCCOM ATTN: AMCPM-IL Dover, NJ 07801
1	Commander US Army Armament Materiel Command ATTN: AMSAR- SF Rock Island, IL 61299
1	Commander US Army Armament Munitions & Chemical Command ATTN: AMSMC- LEP-L Rock Island, IL 61299
1	Director Benet Weapons Laboratory US Army AMCCOM ATTN: SMCAR-LCB-TL Watervliet, NY 12189
1	Air Force Armament Laboratory ATTN: AFATL/DLODL Eglin AFB, FL 32542
1	AFWL/SUL Kirtland AFB, NM 87117

No. of Copies	Organization
1	Commander US Army Aviation Research and Development Command ATTN: AMSAV-E 4300 Goodfellow Boulevard St. Louis, MO 63120
1	Director US Army Air Mobility Research and Development Laboratory Ames Research Center Moffett Field, CA 94035
1	Commander US Army Communications Research and Development Command ATTN: AMSEL-ATDD Fort Monmouth, NJ 07703
1	Commander US Army Electronics Research and Development Command Technical Support Activity ATTN: AMDSD-L Fort Monmouth, NJ 07703
1	Commander US Army Missile Command ATTN: AMSMI-R Redstone Arsenal, AL 35898
1	Commander US Army Missile Command ATTN: AMSMI-YDL Redstone Arsenal, AL 35898
1	Commander US Army Missile Munitions Center & School Redstone Arsenal, AL 35898
1	Commander US Army Mobility Equipment Research & Development Command ATTN: AMXME-ND Fort Belvoir, VA 22060

DISTRIBUTION LIST

No. of Copies — Organization

1 Commander
US Army Tank Automotive Command
ATTN: AMSTA-TSL
Warren, MI 48090

1 Director
US Army TRADOC Systems Analysis Activity
ATTN: ATAA-SL
White Sands Missile Range, NM 88002

2 Project Manager
Ammunition Logistics
ATTN: COL P. Greenberg
Mr. G. Goble
Dover, NJ 07801

1 Commandant
US Army Infantry School
ATTN: ATSH-CD-CSO-OR
Fort Benning, GA 31905

1 Commander
US Army Defense Ammo Center & School
ATTN: John Byrd
Savanna, IL 61074

1 Commander
US Army Research Office
ATTN: Chemistry Division
P.O. Box 12211
Research Triangle Park, NC 27709-2211

1 Commander US Army Europe
ATTN: Chief of Staff
APO New York, NY 09403

1 Commander US Army Europe
ATTN: AEAGA-SE
APO New York, NY 09403

1 Commander US Army Europe
ATTN: G-4
APO New York, NY 09403

No. of Copies — Organization

1 Commander
Naval Sea Systems Command
ATTN: Mr. R. Beauregard, SEA 64E
Washington, DC 20362

1 Commander
Naval Explosive Ordnance Disposal Facility
ATTN: Technical Library, Code 604
Indian Head, MD 20640

1 Commander
Naval Research Lab
ATTN: Code 6100
Washington, DC 20375

1 Commander
Naval Surface Weapons Center
ATTN: Code G13
Dahlgren, VA 22448

1 Commander
Naval Surface Weapons Center
ATTN: J. Ward, R15
Silver Spring, MD 20910

1 Commander
Fleet Marine Force, Atlantic
ATTN: G-4 (NSAP)
Norfolk, VA 23511

Aberdeen Proving Ground

Dir, USAMSAA
ATTN: AMXSY-D
AMXSY-MP, H. Cohen
AMXSY-R, R. Simmons
Cdr, USATECOM
ATTN: AMSTE-TO-F
Cdr, USAHEL
ATTN: Jack Waugh
Cdr, CRDC, AMCCOM,
ATTN: SMCCR-RSP-A
SMCCR-MU
SMCCR-SPS-IL

USER EVALUATION SHEET/CHANGE OF ADDRESS

This Laboratory undertakes a continuing effort to improve the quality of the reports it publishes. Your comments/answers to the items/questions below will aid us in our efforts.

1. BRL Report Number_____ Date of Report_____

2. Date Report Received_____

3. Does this report satisfy a need? (Comment on purpose, related project, or other area of interest for which the report will be used.)_____

4. How specifically, is the report being used? (Information source, design data, procedure, source of ideas, etc.)_____

5. Has the information in this report led to any quantitative savings as far as man-hours or dollars saved, operating costs avoided or efficiencies achieved, etc? If so, please elaborate._____

6. General Comments. What do you think should be changed to improve future reports? (Indicate changes to organization, technical content, format, etc.)

CURRENT ADDRESS

Name

Organization

Address

City, State, Zip

7. If indicating a Change of Address or Address Correction, please provide the New or Correct Address in Block 6 above and the Old or Incorrect address below.

OLD ADDRESS

Name

Organization

Address

City, State, Zip

(Remove this sheet along the perforation, fold as indicated, staple or tape closed, and mail.)